COMMONWEALTH OF MASSACHUSETTS

Mitt Romney, Governor

Kerry Healey, Lieutenant Governor

Department of Housing and Community Development
Bureau of Energy Programs

Jane Wallis Gumble, Director

WEATHERIZATION ASSISTANCE PROGRAM TECHNICAL MANUAL

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Contributions by the Department of Housing and Community Development

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US Department of Energy Weatherization Assistance Program Mission Statement

"To reduce heating and cooling costs for low-income families, particularly for the elderly, people with disabilities, and children, by improving the energy efficiency of their homes while ensuring their health and safety."

This Massachusetts Weatherization Assistance Program Technical Manual is intended to be used in conjunction with the Northeast Weatherization Field Guide to provide comprehensive technical guidelines on appropriate weatherization protocols and techniques.

TABLE OF CONTENTS

STANDARDS FOR WEATHERIZATION MATERIALS

Commonwealth of Massachusetts
Department of Housing and Community Development
Bureau of Energy Programs

REVISED APRIL 1, 2002

THERMAL INSULATING MATERIALS FOR BUILDING ELEMENTS INCLUDING WALLS, FLOORS, CEILINGS, ATTICS, AND ROOFS

	STANDARDS
Insulation: Mineral Fiber	
Blanket/Batt.	ASTM[1] C665-98
Roof Insulation Board	ASTM C726-00a
Loose-Fill.	ASTM C764-99
Insulation: Mineral Cellular	
Vermiculite Loose-Fill.	ASTM C516-80 (1996)e1
Perlite Loose-Fill.	ASTM C549-81 (1995)e1
Cellular Glass Block.	ASTM C552-00
Perlite Board	ASTM C728-97
Insulation: Organic Fiber	
Cellulosic Fiber Insulating Board.	ASTM C208-98
Cellulose Loose-Fill.	ASTM C739-00
Insulation: Organic Cellular	
Rigid Celluar Polystryrene . . .	ASTM C578-95
Preformed Unfaced Rigid Polyurethane Insulation . . .	ASTM C591-00
Polyurethane or Polyisocyanurate Board Faced With Aluminum Foil on Both Sides	F.S.[2] HH-I-1972/1 (1981)
Polyurethane or Polyisocyanurate Board Faced With Felt on Both Sides	F.S. HH-I-1972/2 (1981)

[1]ASTM indicates American Society for Testing and Materials.

[2]F.S. indicates Federal Specification.

STANDARDS

Insulation: Composite Board

Mineral Fiber and Rigid Cellular Polyurethane Composite Roof Insulation Board.	ASTM C726-00a
Gypsum Board and Polyurethane or Polyisocyanurate Composite Board	F.S. HH-I-1972/4 (1981)
Materials Used As A Patch To Reduce Infiltration Through The Building Envelope	Commercial Availability

THERMAL INSULATING MATERIALS FOR PIPES, DUCTS, AND EQUIPMENT SUCH AS BOILERS AND FURNACES

	STANDARDS
Insulation: Mineral Fiber	
Preformed Pipe.	ASTM C547-00
Blanket and Felt Insulation (Commercial and Industrial Type)	ASTM C553-00
Blanket Insulation and Blanket Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).	ASTM C592-00
Block and Board	ASTM C612-00
High Temperature Fiber Blanket Insulation	ASTM C892-00
Insulation: Mineral Cellular	
Calcium Silicate Block and Pipe	ASTM C533-95
Cellular Glass.	ASTM C552-00
Molded Expanded Perlite Block and Pipe . . .	ASTM C610-99
Insulation: Organic Cellular	
Preformed Flexible Elastomeric Cellular in Sheet and Tubular Form . . .	ASTM C534-99
Unfaced Preformed Rigid Cellular Polyurethane	ASTM C591-00

FIRE SAFETY REQUIREMENTS FOR THERMAL INSULATING MATERIALS ACCORDING TO INSULATION USE STANDARDS

	STANDARDS
Attic Floor.	Insulation materials intended for exposed use in attic floors shall be capable of meeting the same smoldering combustion requirements given for cellulose insulation in ASTM C739-00.
Enclosed Spaces	Insulation materials intended for use within enclosed stud or joist spaces shall be capable of meeting the smoldering combustion requirements given for cellulose insulation in ASTM C739-00.
Exposed Interior Walls & Ceilings	Insulation materials, including those with combustible facings, which remain exposed and serve as wall or ceiling interior finish shall have a flame spread classification not to exceed 150 (per ASTM E84-00a).
Exterior Envelope Walls and Roofs	Exterior envelope walls and roofs containing thermal insulation shall meet applicable local government building code requirements for the complete wall or roof assembly.
Pipes, Ducts, and Equipment	Insulation materials intended for use on pipes, ducts, and equipment shall be capable of meeting a flame spread classification not to exceed 150 (per ASTM E84-00a).

STORM WINDOWS

	STANDARDS
Exterior Storm Windows	
Aluminum Insulating	ANSI/AAMA[3]1002.10-93
Aluminum Frame.	ANSI/AAMA 1002.10-93
Wood Frame.	Section 3 of ANSI/NWWDA[4] I.S. 2-97.
Frameless Plastic Glazing	Required minimum thickness 6 mil (0.006 inches) basement windows only.
Moveable Insulation Systems for Windows (Quilts)	Commercial Availability
Interior Storm Windows.	A demonstrated ten (10) year effective life expectancy with a rigid frame.

[3]ANSI/AAMA indicates American National Standards Institute/Architectual Aluminum Manufacturers Association.

[4]ANSI/NWWDA indicates American National Standards Institute/National Wood and Door Association.

REPLACEMENT WINDOWS

STANDARDS

Replacement Windows

Aluminum Frame.	ANSI/AAMA 101/I.S. 2-97
Steel Frame	Steel Window Institute Recommendation Specifications for Steel Windows, 1990
Wood Frame.	ANSI/NWWDA I.S.2-97.
Rigid Vinyl Frame…….	ASTM D4726-00

NOTE: *Sealed insulated glass units shall be warranted against failure of the seal for a period of at least ten (10) years.*

Replacement windows other than wood must have a built in thermal break.

REPLACEMENT DOORS

STANDARDS

Replacement Doors

Hinged Doors

Steel	ANSI A250.8-98
Wood	
Flush	Exterior door provisions of ANSI/NWWDA I.S. 1-97
Pine, Fir, Hemlock, Spruce. . .	ANSI/NWWDA I.S. 6-97

Sliding Glass Doors

Aluminum.	ANSI/NWWDA 101/I.S 2-97
Wood.	ANSI/NWWDA I.S. 3-88

CAULKS AND SEALANTS

STANDARDS

Caulks and Sealants	Minimum 20-year life.
Glazing Compound	ASTM C669-00
Oil and Resin Base Caulks	ASTM C570-00
Acrylic (Solvent Type) Sealants	ASTM C920-98e1
Butyl Rubber Sealants	F.S. Commercial Item Description A-A-272 (6/7/95)
Chlorosulfonated Polyethylene Sealants	ASTM C920-98e1
Latex Sealing Compounds	ASTM C834-00e1
Elastomeric Joint Sealants (Normally considered to include polysulfide, polyurethane, and silicone).	ASTM C920-98e1
Preformed Gasket and Sealing Materials	ASTM C509-00
Backer Rod, Oakum, Untreated Jute, Natural Fiber Twine, Synthetic Twine, or other suitable material	Commercial availability.
Duct Sealing Materials	Pressure Sensitive or Heat Activated Tape or mastic. Conformance to U.L. 181A or 181B

COMPACT FLUORESCENT LIGHT BULBS

CFLs…….	UL approved and an approved electric utility product

WEATHERSTRIPPING

STANDARDS

Weatherstripping.	Must be permanently installed with fasteners (tacks, staples, brads, etc.) and must have a demonstrated life expectancy of at least five (5) years. All V-strip weatherstripping must be of the pre-molded type with an effective memory .

VAPOR RETARDERS

STANDARDS

Vapor Retarders.	Selected according to the provisions cited in ASTM C755-97; permeance not greater than 1 perm when determined according to the desiccant method described in ASTM E96-00.
Items to Improve Attic Ventilation. . . .	Commercially available

SKIRTING

STANDARDS

Skirting.	Commercially available

CLOCK THERMOSTATS

STANDARDS

Clock Thermostats	Listed by U.L. Conformance to NEMA[5] DC 3-1989 (R1996)

BOILER/FURNACE CONTROL SYSTEMS

STANDARDS

Automatic Set-Back Thermostats.	Listed by U.L. Conformance to NEMA DC3-1989 (R1996)
Line Voltage or Low Voltage Room Thermostats	Listed by U.L. Conformance to NEMA DC3-1989 (R1996)
Hydronic Boiler Controls	Listed by U.L.
Energy Management Systems	Listed by U.L.
Other Burner Controls	Listed by U.L

[5] NEMA indicates National Electrical Manufacturers Association

WATER HEATER MODIFICATIONS

	STANDARDS
Insulate Tank and Distributing Piping	(See Insulation Standards)
Hot Water Pipe Heater Strips	Listed by U.L
Reduce Thermostat Settings	Set Back to 130^{o}
Install Vent Damper, Gas Fueled	ANSI Z21.66-1996, including Exhibits A and B ANSI Z223.1-1999
Low Flow Water Faucet Aerators	Commercially available. Brass, Chrome plated.
Low Flow Shower Heads	ANSI/ASME A112 18 1.m. Not to exceed 2.5 Gallons Per Minute (GPM). Brass, Chrome plated with Shut-Off.

BOILER REPAIR AND MODIFICATIONS/EFFICIENCY IMPROVEMENTS

	STANDARDS
Replacement Oil Burners	527 CMR Oil Burning Equipment Board of Fire Prevention and NFPA 31-2001.
Gas Power Burners	ANSI Z223.1 1999
Furnaces, Oil	U.L. 727, Eighth Edition, 1994 and NFPA 31-2001 Minimum AFUE 80%
Furnaces, Gas	ANSI Z21.47-1998, and ANSI Z223.1-1999, (Same as NFPA 54-1999) Minimum AFUE 80%.
Boilers	Minimum AFUE 80%
Cleanout/Tune-Up.	Per DHCD/BEP Guidance
Combustion Chambers	NFPA 31-2001
Thermostatic Radiator Valves.	Commercially available. One pipe steam systems require air vents on each radiator; see manufacturers' requirements.

WEATHERIZATION PRIORITY MEASURES

SINGLE-FAMILY AND SMALL MULTI-FAMILY (ONE TO FOUR UNITS)

PRIORITY **SOURCE OF HEAT LOSS AND REMEDY**

1. Major Air Sealing/General Heat Waste/Duct Sealing

   Complete comprehensive Blower Door Directed Air Sealing and seal all exposed ductwork based on the protocol outlined in the Massachusetts WAP Technical Manual.

1a Primary Heating System

   Complete safety and efficiency improvements on the primary heating system based on the guidelines outlined in the most recent HEARTWAP Program Guidance. Heating system work should be referred to HEARTWAP provided sufficient funds exist.

1. Uninsulated Attic (R 19 or less)

   Install attic insulation up to R 38 (R 44 for electric heated homes). Attics must receive a thorough air sealing protocol prior to the installation of insulation.

3. Uninsulated Walls

   Insulate the sidewalls with cellulose insulation installed at a density greater than 3.5 lbs/cubic foot. All cavities must be thoroughly probed prior to the installation. Insulation coverage must be complete.

4. Compact Fluorescent Lighting

   Install 6 compact fluorescent light (CFL) bulbs in fixtures or lamps that are on in excess of an average of three hours per day. CFL installations must be in compliance with the guidelines outlined in the Massachusetts WAP Technical Manual and the Appliance Management Program (AMPs). If a utility's AMP funding is available for the dwelling unit, those funds should be utilized.

5. Uninsulated Floors (*Unconditioned Basements Only*)

   Insulate the floors of dwelling units with an unconditioned basement with R19 fiberglass batts. The fiberglass must be mechanically fastened and all large series leakage paths must receive the proper air sealing treatment prior to the installation of the insulation.

5a. or Uninsulated Perimeter

Conditioned or semi-conditioned basements: Insulate the inside of the exposed foundation walls from the top of the floor joist area to below grade with an R 5 vinyl-backed duct insulation as per the specifications outlined in the Massachusetts WAP Technical Manual.

6. Uninsulated Space Heating Ducts or Pipes Uninsulated Space Heating Ducts or Pipes

Insulate the space heating ducts with R-5 duct insulation. The insulation must be mechanically fastened and all seams on the ductwork must be properly sealed according to specifications outlined in the Massachusetts WAP Technical Manual prior to the installation of the insulation or:

Insulate all uninsulated hydronic or steam pipes with a commercially available pipe insulation appropriate for the pipe temperature in accordance with the Massachusetts WAP Technical Manual.

7. Partially Insulated Attic (R-20 to R-25)

Install attic insulation up to an R-38 (R-44 for electric heated homes). The attic must receive a thorough air sealing protocol, including the moving and replacing of existing insulation, prior to the installation of the additional insulation.

9 Single Glazed Windows

Electrically Heated Homes: Add storm windows (interior or exterior) to single glazed windows. *All other heat sources*: Storm windows shall be added only if the existing single glazed window is in poor condition. A maximum of $75.00 may be spent on a standard storm window (88 united inches) and a total of $500 for storm windows on any individual dwelling unit.

10 Minor General Heat Waste

See Manual Requirements

MULTI-FAMILY (5+Units) PRIORITY LIST

PRIORITY **SOURCE OF HEAT LOSS AND REMEDY**

1. Major Air Sealing/General Heat Waste Reduction

   Complete comprehensive Blower Door Directed Air Sealing and seal all exposed ductwork based on the protocol outlined in this WAP Technical Manual.

1a. Primary Heating System/Distribution System

   Complete safety and efficiency improvements on the primary heating system based on the guidelines outlined in the most recent HEARTWAP Program Guidance. Heating system work should be referred to HEARTWAP, provided sufficient funds exist.

2. Attic Insulation (R-19 or Less Existing)

   Install attic insulation up to R-38 (R-44 for electric heated homes). Attics must receive a thorough air sealing protocol prior to the installation of insulation.

3. Sidewall Insulation

   Insulate the sidewalls with cellulose insulation installed at a density greater than 3.5 lbs/cubic foot. All cavities must be thoroughly probed prior to the installation. Insulation coverage must be complete.

4. Compact Fluorescent Lighting

   Install 6 compact fluorescent light (CFL) bulbs in fixtures or lamps that are on in excess of an average of three hours per day. CFL installations must be in compliance with the guidelines outlined in the Massachusetts WAP Technical Manual and the Appliance Management Program (AMPs). If a utility's AMP funding is available for the dwelling unit, those funds should be utilized.

5. Floor Insulation (Unconditioned Basements)

   Insulate the floors of dwelling units with an unconditioned basement with R19 fiberglass batts. The fiberglass must be mechanically fastened and all large series leakage paths must receive the proper air sealing treatment prior to the installation of the insulation.

5a. or Uninsulated Perimeter

Conditioned or semi-conditioned basements: Insulate the inside of the exposed foundation walls from the top of the floor joist area to below grade with an R 5 vinyl-backed duct insulation as per the specifications outlined in the Massachusetts WAP Technical Manual.

6. Uninsulated Space Heating Ducts or Pipes

Insulate the space heating ducts with R5 duct insulation. The insulation must be mechanically fastened and all seams on the ductwork must be properly sealed according to specifications outlined in the Massachusetts WAP Technical Manual prior to the installation of the insulation.

Or/Insulate all uninsulated hydronic or steam pipes with a commercially available pipe insulation appropriate for the pipe temperature in accordance with the Massachusetts WAP Technical Manual.

7. Attic Insulation (R-20 to R-25 Existing)

Install attic insulation up to an R-38 (R-44 for electric heated homes). The attic must receive a thorough air sealing protocol, including the moving and replacing of existing insulation, prior to the installation of the additional insulation.

8. Storm Windows

Electrically Heated Homes: Add storm windows (interior or exterior) to single glazed windows. *All other heat sources*: Storm windows shall be added only if the existing single glazed window is in poor condition. A maximum of $75.00 may be spent on a standard storm window (up to 88 united inches) and a maximum of $500 for storm windows on any individual dwelling unit.

9. Minor General Heat Waste

See Manual Requirements

MOBILE HOME PRIORITY LIST

PRIORITY SOURCE OF HEAT LOSS AND REMEDY

1. Major Air Sealing/General Heat Waste Reduction/Duct Sealing

   Complete comprehensive Blower Door Directed Air Sealing and seal all exposed ductwork based on the protocol outlined in the Massachusetts WAP Technical Manual.

1a. Primary Heating System

   Complete safety and efficiency improvements on the primary heating system based on the guidelines outlined in the most recent HEARTWAP Program Guidance. Heating system work should be referred to HEARTWAP provided sufficient funds exist.

2. Roof insulation

3. Floor Insulation

4. Compact Fluorescent Lighting

   Install 6 compact fluorescent light (CFL) bulbs in fixtures or lamps that are on in excess of an average of three hours per day. CFL installations must be in compliance with the guidelines outlined in the Massachusetts WAP Technical Manual and the Appliance Management Program (AMPs). If a utility's AMP funding is available for the dwelling unit, those funds should be utilized.

5. Single Glazed Windows

   Add interior storm windows to single glazed windows.

6. Window and Door Replacements

   Replace prime windows and doors only after all other reasonable repair options have been considered and rejected.

MASSACHUSETTS WEATHERIZATION ASSISTANCE PROGRAM
HEALTH AND SAFETY GUIDANCE

The health and safety of clients, subgrantee staff and contractors is of primary concern to the Bureau of Energy Programs. It is important that all personnel maintain a high level of awareness concerning the potential hazards associated with the weatherization process.

The standards set forth in this guidance provide only general guidelines for health and safety concerns. Subgrantee staff and contractors must familiarize themselves with all the health and safety issues associated with weatherization. More specific information concerning indoor air quality problems can be obtained through the Federal Environmental Protection Agency (EPA) and the U.S. Consumer Product Safety Commission. Detailed specifications regarding the health and safety of workers in the construction industry can be found in Construction Industry OSHA Safety and Health Standards (29 CFR 1926/1910) that is available from the U. S. Department of Labor. These standards are applicable to all workers providing services using funding under the WAP program.

Weatherization funds may be obligated to correct Health and Safety problems in a client's homes. These funds may be used only for the "elimination of energy related health and safety hazards which are necessary before or because of the installation of weatherization materials". Further restrictions on the expenditure of Weatherization funds are outlined in this guidance. Subgrantees may spend up to $600.00, *inclusive of all other incidental repairs*, on an individual dwelling unit for health and safety related repairs. The health and safety repairs must be reported in the appropriate cost category on the Building Weatherization Report (BWR). Subgrantees may average up to $85 (material and labor) in health and safety related repairs per dwelling unit over the course of the Weatherization grant.

Each home weatherized by the WAP must be individually assessed to determine the existence of potential hazards to workers or clients. If unsafe conditions exist that would endanger the health or safety of the clients or weatherization workers, and those conditions cannot be corrected, no WAP work may be started on that home.

WORKERS: The Bureau of Energy Programs allows technical waivers for nonperformance of audits, installations and/or inspections, or any portion of these functions, if such action will expose workers to conditions regarded as unsafe or unhealthy as determined by OSHA Construction Industry Standards.

Each worker is responsible for working in a safe manner so as to not endanger either themselves or others. Individuals who continue to demonstrate that they are unable to work in a safe, professional manner will not be retained by the program.

CLIENTS: Subgrantees and their representatives are required to take all reasonable precautions against performing work on homes that will subject clients to health and safety risks. During the energy audit process, the energy auditor will make an evaluation of the individual health of the home's occupants. In cases where a person's health is fragile and/or the weatherization activities would constitute a health or safety hazard, the occupants will be required to leave during the work process or the agency and contractor should not begin the work. Work that is completed should in no way contribute to or create an unhealthy condition in the home. All problems and concerns must be fully documented in the client file.

Client and worker education may be the most important tool in dealing with health and safety concerns in the Weatherization Program. Educated clients and workers are far more likely to conduct themselves in a manner that is consistent with program goals.

Indoor Air Quality and Environmental Concerns

Weatherization activities will have a significant effect on how a home works. As building tightness increases and the infiltration rate decreases, air quality problems can become an unintentional consequence. Low concentrations of pollutants or water vapor may become higher, potentially dangerous concentrations. Combustion and venting characteristics of heating systems and domestic hot water heaters may be affected, causing the release of unhealthy combustion by-products into the living space. It is crucial that the agency inspector be aware of the interactions between building tightness and potential indoor air quality problems. Ductwork leakage will play a role in this whole formula. An important part of the initial inspection of the home must be a thorough evaluation of potential indoor air quality problems.

The initial inspection must include the following:

- Blower Door testing consistent with the WAP Technical Manual
- Carbon Monoxide testing of all combustion appliances.
- Evaluation of the venting system, including backdraft testing, of all vented appliances.
- A complete evaluation of existing and potential moisture problems.
- A determination of the existence of any one of a number of hazardous substances (asbestos, lead paint, volatile organic compounds) that may be stored in the home.

If there are existing problems, work must not commence until steps are taken to mitigate the problems.

To ensure that the WAP work that was completed does not create potential problems, each Quality Control visit must include;

- A final Blower Door test after <u>all</u> work has been completed. This test must be consistent with the WAP Technical to ensure that building tightness recommendations have not been exceeded.
- A carbon monoxide test of all combustion appliances.
- A thorough evaluation of the venting characteristics of all combustion appliances, including testing for spillage and backdrafting.
- An evaluation of the moisture conditions in the home and the attic (if attic work was completed).

If the final Quality Control inspection indicates that a problem exists, the agency must correct the problem prior to submitting the unit as a completion.

Following is an overview of some of the potential health and safety risks that may be associated with home weatherization and suggested approaches to minimize exposure.

Asbestos

Description: Fibrous, non-combustible mineral.

Health/Safety Concerns: Asbestos fibers are microscopic. When disturbed and released into the air, the fibers can be inhaled. Significant exposure may result in lung cancer, asbestosis or mesothelioma.

Sources in Homes: Until its use was strictly limited in the l970's asbestos was used in a large number of building products. The most common applications that could involve interaction with weatherization personnel include:

boiler insulation
furnace insulation
pipe insulation
duct insulation

Workers may encounter asbestos in plaster, joint compound, sidewall and roof shingles, floor tiles and other building products, particularly when these items are disturbed.

To minimize exposure:

- Learn to recognize suspected asbestos containing materials.

- Avoid disturbance of friable asbestos containing materials (ACM). Friable asbestos is "any material containing greater than one percent asbestos by weight or volume that hand pressure can crumble, pulverize or reduce to powder when dry, or any asbestos containing materials that can reasonably be expected, as a result of the demolition or renovation to be undertaken, to become pulverized through breaking, chipping, crumbling, crushing, or other means of rendering fibers available to the ambient air."

- DO NOT CONDUCT A BLOWER DOOR TEST ON A BUILDING WHERE **FRIABLE** ASBESTOS IS PRESENT.

- Provide information to clients regarding the existence of suspected ACM and provide client education advising non-disturbance of such materials.

WAP funds may not be used to complete Asbestos Abatement work unless extreme mitigating factors exist and BEP's prior approval is granted ($600 WAP repair maximum).

Asbestos abatement can be completed as part of a heating system replacement consistent with the "Asbestos Abatement Guidance" of the HEARTWAP Program Guidance.

This information is a general program guidance for Weatherization personnel and does not provide the detailed specifications for the proper handling of ACM. State law concerning asbestos abatement can be found in Commonwealth of Mass. Department of Public Health Asbestos Abatement Regulation; CMR 410.353.

Lead

Description: A metal contained in paints and various other substances.

Health/Safety Concerns: Ingestion or absorption of lead into the blood stream is a serious health hazard causing brain damage over a period of time. This can be a particularly serious problem with small children, who may ingest paint chips or flakes, or dust contaminated with lead products. Serious learning disabilities can result from excessive lead levels in the bloodstream. Workers can be contaminated in the same way as children, but are most likely to be exposed by breathing dust contaminated by sanding or planing surfaces that contain lead based paints.

Sources in Homes: Lead paint is the primary source of lead in a home. Contamination occurs when lead paint is disturbed by sanding, chipping, or flaking. Lead is also present in the solder used in plumbing pipe joints. Lead can leach into potable water, particularly when water is stagnant in the pipes for a length of time. To a lesser degree, lead contamination can result from inks used in newspapers and magazines.

To minimize risks to clients and Weatherization personnel:

- **DO NOT DISTURB LEAD PAINT, except when absolutely necessary, particularly in homes with young children.** Staff and contractors should assume that any paint on windows and doors contains lead unless it has been verified otherwise. **WHEN THERE IS A POSSIBILITY OF DISTURBING LEAD DURING THE WEATHERIZATION PROCESS, WAP CONTRACTORS MUST STRICTLY ADHERE TO REQUIRED LEAD-SAFE PROTOCOLS AS STATED IN HUD'S LEAD PAINT SAFETY FIELD GUIDE FOR PAINTING, HOME MAINTENANCE AND RENOVATION WORK.**

- Provide clients and workers with information regarding the dangers of lead poisoning.

  When working on sidewalls that may contain lead based paint, steps should be taken to minimize and contain debris, paint chips, and to avoid the ingestion of lead dust. These steps must include, but are not limited to the following:

  Keeping children and pets away from the work area.

  Covering the ground beneath the work area with six (6) mil. polyethylene plastic or drop clothes to catch falling debris. Carefully remove the plastic or drop cloth after the work is completed.

  Closing all windows and doors to ensure that dust does not blow into the home.

  Worker Protection

  Detailed specifications regarding the health and safety of workers in the construction industry can be found in Construction Industry OSHA Safety and Health Standards (299CFR 1926/1910). **Also refer to Section 5.13 Lead- Safe Weatherization within the Northeast Weatherization Field Guide.**

ALL CONTRACTORS WORKING IN THE MASSACHUSETTS WEATHERIZATION ASSISTANCE PROGRAM MUST RECEIVE LEAD-SAFEWEATHERIZATION TRAINING AND BE CERTIFIED THROUGH HUD'S LEAD-SAFE RENOVATION PROGRAM.

Generalized lead paint removal is not an allowable activity under the Weatherization Assistance Program. The information in this guidance is not intended to provide specific information for the proper handling of lead. For detailed information regarding lead paint abatement see Commonwealth of Mass. Publications 454 CMR 22.00 and 460 CMR.

Combustion Systems

Definition: Fuel burning appliance used for water and/or space heating.

Health/Safety Concerns:

- Combustion of surrounding materials resulting from unsafe operation of the heating system.
- Release of unhealthy combustion products into the home environment due to a cracked heat exchanger, improper venting, spillage, or backdrafting of the appliance. Many combustion byproducts have significant adverse health effects. Some of these byproducts include, carbon monoxide, carbon dioxide, nitrogen dioxide, sulfur dioxide, and particulate matter. Each byproduct may have specific health related problems depending on the concentration.
- Health hazards resulting from dysfunctional heating system (no heat).
- Gas leaks - risk of contamination of house air or explosion.
- Scalding due to water temperature set too high.

To minimize risks:

- Provide proper clearances, as required by the appropriate building code, between combustible materials and wood/coal stoves, kerosene heaters, furnaces, boilers, water heaters and flues. The National Fire Prevention Association's Manual on Clearances for Heat Producing Appliances provides a listing of minimum clearances for most combustion appliances.
- **IF THERE IS AN UNVENTED COMBUSTION SPACE HEATER BEING USED IN THE BUILDING, THE AGENCY POLICY MUST BE TO DECLINE WEATHERIZATION SERVICES UNTIL THE CLIENT SIGNS AN AGREEMENT THAT THE HEATER WILL BE REMOVED FROM THE DWELLING AND WILL NOT BE USED AFTER THE WORK HAS BEEN COMPLETED.**

  Be certain that all heating appliances and water heaters have an adequate venting system, sufficient draft, no spillage of combustion products, no backdrafting when all exhaust fans are running. Test for carbon monoxide before and after Weatherization and service all appliances that exhibit more than 100 ppm in the combustion products. All homes with vented appliances must receive a backdraft test. Be certain that the air handler of forced warm air furnaces are not contributing to backdrafting problems. If the test demonstrates a backdraft problem, the agency must take the necessary steps to rectify the situation. The results of the test and/or the resolution of any problems must be documented in the client file.
- Test the ambient air around combustion appliances, including gas ranges, for carbon monoxide after about 5-10 minutes of stove operation. Those that create CO levels in excess of 9 ppm in the ambient air must be serviced. Ambient air should be tested in an area around the combustion appliance where a client is likely to be standing.

- Be certain that the furnace heat exchanger is not cracked.

- Provide adequate combustion air for all combustion systems.

- For wood and coal stoves, provide a clean chimney. For any unvented space heating appliances, provide client education regarding the health and safety hazards associated with the operation of such equipment, and do not start any weatherization work in homes with improperly vented heating equipment until the problems are corrected.

- Check for and repair all gas leaks.

- Turn down water heater temperatures when necessary.

WAP Repair and/or Health and Safety Repair funds may be used to correct problems in combustion appliances, including water heaters and dryers. Problems with space heating appliances may be referred to the HEARTWAP Program, provided that the required work can be completed before the WAP work begins. In homes that are occupied by tenants, any combustion problems that are created by gas cook stoves and ovens and improperly vented domestic hot water heaters are the responsibility of the property owner.

Carbon Monoxide

While carbon monoxide is a by-product of combustion systems, and as such was addressed in the previous section of this guidance, the potential for serious injury and death from this gas warrants that it be addressed separately.

Carbon monoxide is a product of incomplete (poor) combustion. It is a direct and cumulative poison. When combined with blood hemoglobin, CO replaces oxygen in the blood until it completely overcomes the body. Low level CO poisoning symptoms include headaches, confusion, dizziness, nausea, vomiting, convulsions, sleepiness, stinging eyes, and loss of muscular control. Death from CO poisoning occurs suddenly. The victim inhaling the toxic concentration of the gas may become helpless before realizing that danger exists.

To minimize risks of CO exposure;

- Provide for the proper ventilation of all combustion appliances.

- Test for spillage, backdrafting, and CO levels of gas fired appliances prior to beginning and upon completion of all WAP jobs. To ensure the safety of the occupants BEP has set a maximum CO level in flue gas products of 100 ppm. The maximum allowable CO level in ambient air surrounding an appliance is 9 ppm.

- Provide any required service of combustion appliances that exhibit high levels of CO in the flue gases or ambient air.

- Test the operation of all gas fired cook stoves and ovens after 5-10 minutes of operation. Ambient air CO readings near the range should not exceed 9 ppm.

- Inform clients if a CO problem exists and recommend any temporary action to ensure client safety until the offending appliance can be serviced. Conduct no weatherization activities that will tighten the home until it can be verified that the CO problem has been resolved.

The effects of Carbon Monoxide poisoning are cumulative. Effects can vary significantly based on age, sex, weight, and overall state of health. Children, the elderly, and the infirm may be seriously effected by even low levels of CO depending on the concentration and exposure period.

Other Air Quality Concerns

In addition to asbestos, lead, and combustion systems, there are a number of other sources of indoor air pollutants in homes that may present health risks to clients. Awareness of indoor air pollutants and attention on the part of weatherization personnel to the level of air-tightening measures performed on a home will aid in the prevention of making a bad situation worse. Blower door testing provides important information about air leakage levels in homes. Weatherization personnel also must be aware of mechanisms by which pollutants may enter the living space.

A. Biologicals - Molds, mildews, and spores, primarily caused by excessive moisture levels in a home. These substances can be a significant contributing factor in a number of health problems. Excessive moisture in a home provides an environment that allows molds and mildews to flourish. Homes with potential moisture problems should not be tightened until measures are taken to mitigate the moisture sources. The medical profession may misdiagnose many bronchial or asthma problems as being a result of "dry air" due to the presence of a forced warm air heating system. The Doctor may suggest adding a humidifier to the home when the actual problem may be a result of too much moisture in the home, allowing the growth of molds, mildews, and fungal spores.

B. Radon - An odorless, colorless gas that occurs naturally in the earth's crust. Long-term exposure to elevated levels may cause lung cancer. Radon mitigation is not an allowable activity under the WAP. In homes where there is an existing identified radon problem, work that would exacerbate this problem must be limited.

C. Volatile Organic Compounds (VOC) - Cleaning fluids, paints, solvents, herbicides, pesticides, and formaldehyde. VOCs are known to be potential irritants to lungs, eyes, and skin. Some VOC's may be carcinogenic. Frequently stored under sinks, in closets, and basements. Formaldehyde may be found in a variety of building components including plywood, carpeting, and particleboards. Recommend moving potentially dangerous material outside of living space into sheds or garages. Basements are not recommended for storage, particularly if leaky ductwork exists.

D. Airborne Particulate Matter - (primarily tobacco smoke or smoke from improperly vented wood stoves). Known to cause lung cancer. Excessive air tightening can increase levels of carcinogenic by-products in homes. Homes with high levels of tobacco smoke or other indoor pollutants should not be over tightened.

E. Fiberglass - Fibrous glass insulation material. Fiberglass is known to be an irritant to lungs, eyes and skin. Most preliminary research indicates no long-term negative health effects resulting from exposure to high levels of fiberglass, but some studies have indicated that some types of finely chopped blown-in fiberglass may be a potential carcinogen. Exposed fiberglass should not be left in occupied areas of homes. Workers are advised to wear properly rated respirators and protective clothing when working with or around fiberglass.

To minimize risks associated with indoor air pollutants;

- Provide client education concerning indoor air quality issues; inform clients about potentially dangerous materials being stored in the home, problems associated with excessive moisture and recommend solutions.

- Identify potential moisture problems. Look for evidence of problems. Identify sources of moisture. Some potential sources of excessive moisture in a home include;

  Dirt crawlspaces with no vapor barrier, standing water in the basement or crawlspace, unvented (or defective) combustion appliances, unvented clothes dryers, firewood stored in the basement or living space, excessive house plants, large number of inhabitants in small living space, defective plumbing, defective or nonexistent gutters and downspouts.

- Identify all potential sources of indoor pollutants and eliminate, mitigate or ventilate at the source to the greatest degree possible.

- Take pre and post WAP blower door tests, determine air leakage rates, and avoid overtightening homes, especially those with potential indoor air quality problems.

- Control ductwork leakage that may introduce pollutants into the living space. Leaking return ductwork is a major problem in that they can create high negative pressures in the area they are located, and as a result will take whatever pollutants may be in the area surrounding the ductwork, and distribute the pollutants throughout the house. In addition, the negative pressures of leaky returns can cause backdrafting of combustion appliances and also cause the introduction of radon gas into basement areas.

Wiring

Safety Concerns:

- Electric shock while working around wiring in all areas of homes.

- Fire resulting from arcing between loose wiring connections.

- Fire resulting from lack of dissipation of heat due to insulation around heat producing sources.

- Integrity and safety of knob and tube wiring.

To Minimize Risk:

- Workers must demonstrate caution when working around wiring.

- Verify proper wiring connections and proper fusing.

- Verify proper blocking out of insulation around heat producing sources.

- A Licensed electrician must inspect knob and tube wiring and certify its safety, prior to installing insulation (see Attachment A).

Plumbing

Health Concerns:

- Problems resulting from exposure to raw sewage or methane gas.

- Problems resulting from lack of water due to frozen pipes.

To minimize exposure:

- Workers must take precautions to avoid direct contact with raw sewage or other unsanitary conditions. Plumbing fixtures must be properly vented to code to avoid build up of methane gas. Clients must be informed of existing conditions and referred to available resources for assistance.

- Workers must take precautions to avoid creating circumstances which will allow pipes to freeze.

General Workmanship Practices

Chapter XVII, subpart c, item 1926.20 of the Construction Industry OSHA Standards (29 CFR 1926/1910 states: "no contractor or subcontractor for any part of the contract work shall require any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health or safety.

Accident Prevention Responsibilities

(1) It shall be the responsibility of the employer to initiate and maintain such programs as may be necessary to comply with this part.

(2) Such programs shall provide for frequent and regular inspections of the job sites, materials, and equipment to be made by competent persons designated by the employers.

(3) The use of any machinery, tool, material, or equipment that is not in compliance with any applicable requirement of this part is prohibited. Such machine, tool, material, or equipment shall either be identified as unsafe by tagging or locking the controls to render it inoperable or shall be physically removed from its place of operation.

(4) The employer shall permit only those employees qualified by training or experience to operate equipment and machinery."

All WAP personnel, including contractors, working in the Program must conduct themselves within the requirements cited by OSHA. All workers are required to exhibit caution and care during the course of work on the client's homes.

- Use care when working on ladders, in attics, in constricted spaces, or any potentially dangerous situations.

- Use power tools only if familiar with conditions and proper operation of equipment. Be certain that the tools are in good operating condition.

- Wear respirators, protective eye-wear and protective clothing when necessary.

- Provide appropriate clean-up following completion of work.

- Assess structural conditions and demonstrate caution when working in potentially dangerous areas (i.e., on roofs, in attics).

- Do not take foolish chances.

These and other issues are discussed in detail in the OSHA Construction Industry Standards. Subgrantee staff and contractors must become familiar with these regulations. Questions regarding health and safety concerns should be referred to the Bureau of Energy Programs.

Backdrafting

Houses with vented combustion appliances must be tested for spillage and backdrafting as a routine part of the Weatherization process to ensure that the unhealthy byproducts of combustion are not released into the home. Backdrafting occurs when negative pressures caused by exhaust fans or forced warm air distribution fans exceed the ability of the combustion appliance to create or sustain an adequate draft. Backdrafting may occur at anytime during the run cycle of the combustion appliance. If sufficient negative pressures exist in the room where the appliance is located at the start of a run cycle the appliance may never establish a draft and may backdraft for the entire run cycle. The pressures that are needed to create a backdrafting situation are not that great. Natural draft combustion appliances such as gas fired domestic hot water heaters will create only 4-5 pascals (Pa) pressure, the fan of a forced warm air furnace distribution system may create up to 30 p. in the ductwork. Return duct leakage, particularly any leaks that are located near the flue pipe, could cause enough negative pressures in the basement to overcome the draft. Other potential problems include any kitchen or bath fans, fireplaces, wood or coal stoves or anything that exhausts air out of the home. Any Weatherization process that contributes to tightening the home, thereby reducing the available make-up air for any exhaust fan, could cause the combustion appliance to backdraft to supply the required makeup air.

Conducting a Backdraft Test

There are a couple of methods that may be used to conduct a backdraft test. The first involves a mechanical approach using smoke, or a draft gauge. The second, more accurate method involves pressure testing.

Simplified Backdraft testing procedure;

•Put the house in the worst-case winter mode, all exterior doors and windows closed. Turn on all exhaust appliances, furnaces, boilers, water heaters, clothes dryers, and the furnace fan, if applicable. Then, using a draft or pressure gauge, check the exhaust stream of all vented appliances to be certain that there is adequate draft. An alternative to using the draft or pressure gauge is to use a source of smoke at the draft hood or barometric damper of each vented appliance and ascertain that the appliance is drafting properly. If the smoke or air is not moving rapidly up the chimney while all the exhausts and FWA distribution fans are running, a backdrafting problem may exist.

Pressure testing method;

- Put the house in the winter mode, with all exterior doors and windows closed.
- Close all interior doors.
- Turn on the furnace fan, if applicable.
- Close the door leading to the room that contains the vented appliance and measure the pressure difference across that door while the distribution fan and any other exhaust devices located in that room are operating. A negative pressure across the furnace room door is not acceptable. There should be either no pressure difference or a slight positive pressure in the furnace room.
- Open the door to the furnace room. Turn on all exhaust devices throughout the house and leave any doors between those devices and furnace room open. Measure the pressure difference

between the furnace room and the exterior of the house by running a hose attached to the pressure gauge to a penetration outside the house.

- Use the House Depressurization Limits (HDL) table to determine the maximum level of depressurization that is acceptable, based on the heating unit.

- If the depressurization measured in the furnace area is higher than the limited indicated by the table, then the vented combustion appliances are susceptible to extended periods of backdrafting or spillage when exhaust devices are in operation.

House Depressurization Limits

Heating Appliance	HDL in Pascals
Gas Combustion Unit, Natural Draft Interior Combustion Air	5
Oil Combustion Unit, Natural Draft Interior Combustion Air	5
Fireplace, Natural Draft Interior Combustion Air	5
Air tight Woodstove	10
Induced Draft Appliance	10

If a home fails a backdraft test, it is crucial that the agency develop a strategy to alleviate the problem. The venting system of the offending appliance must be thoroughly checked for any problems or obstructions. Providing external combustion air to the appliance may help. Sealing leaks on the return side of forced warm air distribution systems also may help. Sometimes the basement perimeter must be left deliberately leaky to prevent negative pressure build up in the basement.

MAJOR AIR SEALING/ GENERAL HEAT WASTE

The Major Air Sealing/General Heat categories are to be considered as Priority #1 for all housing types and include the following mandatory weatherization measures which must be completed, if applicable, before advancing to any subsequent priority item.

- Seal major bypasses with emphasis on those in the attic
- Seal appropriate key junctures
- Limited weatherstripping and interior caulking as needed for gross air leakage and to increase comfort
- Seal warm air ductwork joints (supplies and returns) and repair all duct leaks as needed
- Domestic hot water (DHW) tank insulation (R-5) and first six (6) feet of DHW pipe
- Fireplace damper
- Weatherstrip doors as needed

MINOR GENERAL HEAT WASTE

The Minor General Heat Waste category is a list of additional measures that may be implemented upon completion of all other applicable energy conservation measures.

- Electrical outlet/switch gaskets
- Low Flow Showerhead
- Water Faucet Aerators
- DHW Pipe Insulation beyond the first six (6) feet
- Sill insulation (faced R-11 fiberglass)

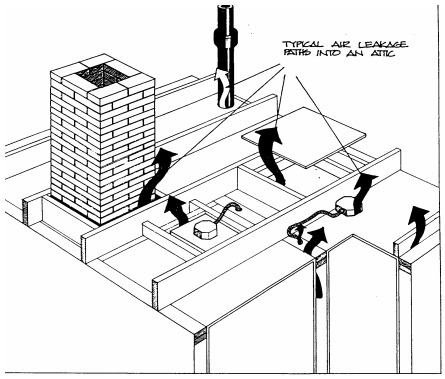
MAJOR AIR SEALING PRIORITIES

Blower door directed air sealing is a comprehensive approach to controlling infiltration in a home. A well developed air sealing strategy can make a home less drafty, more comfortable, and increase the effectiveness of insulation measures by blocking off thermal bypasses. However, any work that reduces the air infiltration rate, must also address concerns about indoor air quality and the venting of combustion by-products. Before any work is completed on a home there must be a thorough evaluation of the home to identify and provide solutions for a variety of potential indoor air quality problems and combustion system venting requirements. These concerns and a required protocol are addressed in the **BEP HEALTH AND SAFETY GUIDANCE**. Required at a minimum is an evaluation and mitigation of potential indoor air quality problems, including moisture problems, carbon monoxide testing of all combustion appliances, and backdraft testing of all vented combustion appliances. All evaluations, testing, and mitigation must be completed both before the weatherization work is started, and after all weatherization work is completed.

All single family and mobile homes must receive a pre-WAP and post-WAP single point blower door test which will provide the subgrantee with a pre and post cubic feet per minute infiltration rate at fifty Pascal (cfm 50). BEP strongly encourages the use of blower door testing in multi family homes. The results of the tests must be recorded and included as part of the WAP audit and quality control information. This requirement can only be waived if there are justifiable concerns over the health and safety of the occupants or testers being compromised by conducting the blower door test (i.e. friable asbestos present in the home). Any justification for not completing the test must be included in the WAP client file. The blower door test may be completed by the WAP auditor or a contractor, but if the contractor is completing the test, the subgrantee must be able to verify the results. Conducting the initial test with the contractor is strongly encouraged. This will give the auditor and the contractor the opportunity to discuss the results of the test, identify major air leakage areas, and to discuss the proposed work.

Since the standard cfm 50 test does not incorporate the volume of the house, BEP recommends that auditors become familiar with and calculate the Air Changes per Hour at 50 Pascal (ACH50) and the Air Changes Natural (ACH_N) and use the resulting information to assist in prioritizing an air sealing strategy.

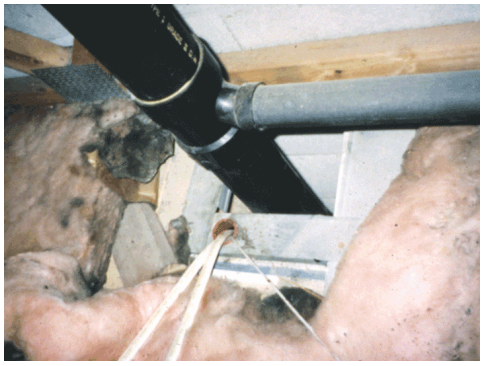
Prioritizing the air sealing work must involve an understanding of how air moves and leaks through the building envelope, estimating the resources (and dollars) that should be devoted to air sealing, (based on the air leakage rate and the amount and type of other work required on the home), and understanding the interactions that occur between the structural and mechanical systems of the home. The auditor and Weatherization contractor must become familiar with effective air sealing techniques and materials. The auditor must also be aware of the recommended Building Tightness Limits (BTL), the interaction of some insulation measures, (primarily wall insulation) with the infiltration rate, and the effect that reducing the infiltration rate will have on the concentration of indoor air pollutants and the venting of combustion appliances.



Comprehensive targeted attic air sealing should always precede attic insulation. Together these weatherization measures form the most cost-effective durable and practical improvement available to site-built homes with insulation levels at or below R-19.

In order for a leak to occur in a building, there must be two components, a hole, and a driving force to move the air through the hole. The amount of leakage through any hole is directly proportional to the size of the hole and the amount of pressure across the hole. It therefore makes the most sense to

concentrate initial air sealing efforts in the areas with the largest holes that are under the highest pressure. Due to the stack effect creating high exfiltration pressures in the upper regions of the building and the large number of potential holes or bypasses in the attic/living space interface, a large amount of the initial air sealing efforts should be focused on identifying and sealing air leakage areas to the attic.



Many of the leakage areas to the attic are actually part of a series leak that may end up either in the living space or the basement. In most of these series leaks, if the leak is controlled in the attic, there is no need to seal the other areas in the series. Some of these potential leakage areas include: chimney chases, plumbing chases, bathroom plumbing walls, attic accessways (including pulldown stairways), open or unsealed top plates, especially in balloon framed homes, the center bearing wall top plate especially in modular homes, split levels and balloon framed structures, around electrical junction boxes.

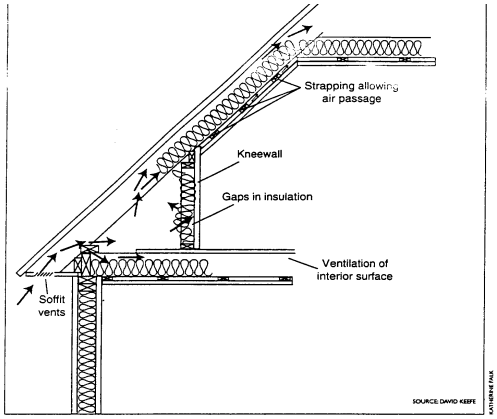
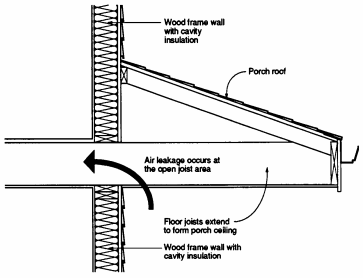
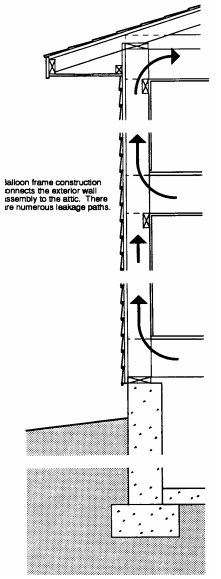


Figure 1. Air leakage pathways through a kneewall. Even an insulated kneewall space often allows significant air leakage. In effect, the interior floor of the second story can be directly ventilated with outdoor air.

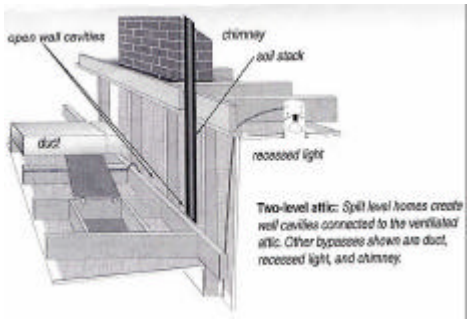
Another area that merits careful inspection and evaluation is a number of key junctures in the home. Anytime that there is a junction of dissimilar materials or areas of structural change in the building, the potential for significant leakage areas exist. Particularly problematic is the kneewall/kneewall floor junction in the Cape Cod style home. In many Capes there is a direct connection between the joist space between the first and second floors of the home and the outside. If this is the case, one of the most cost effective air sealing measures may be to air seal that transition area.



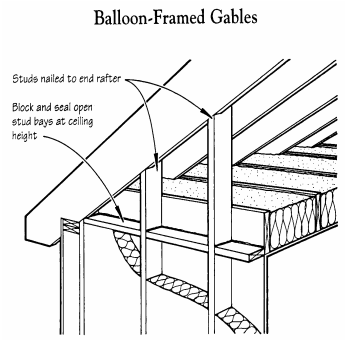
Other key juncture areas to pay particular attention to include, cantilevered floor areas, offset floors and ceilings, the central wall of split level homes, and the wall/roof area where a roofed porch meets the sidewall of the home. Porch roof/wall intersections have two major potential problem areas. First, many ceiling areas of porches are created as extensions of the home's ceiling joists, leaving an open cavity from above the porch ceiling into the area between the floors. The second problem in this area is that in older homes with plank (rather than plywood) sheathing, the area between the porch roof and ceiling may be open to the sidewall cavity. In many homes, the gable end studs may be balloon framed. If this condition exists, special attention to this area may be warranted.



The sidewalls of balloon-framed structures are a major air leakage problem. Since by design, the framework is open at the bottom and top of each bay and into each joist cavity between floors, balloon framed walls communicate directly from the basement to the attic and between the floors throughout the building. Insulating the walls with dense pack cellulose is a very cost effective solution to the problem. In many balloon-framed homes the central bearing partition is also balloon framed and should be air sealed in the attic (and in the basement if needed).

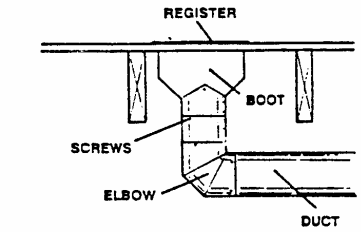


Split level homes pose many potential air leakage areas particularly any wall cavities connected to ventilated attics or crawlspaces.

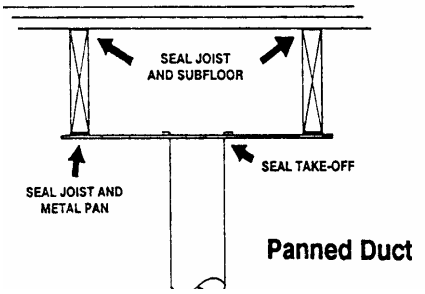


See the accompanying diagrams to assist in identifying some of the areas to concentrate the structural air sealing efforts.

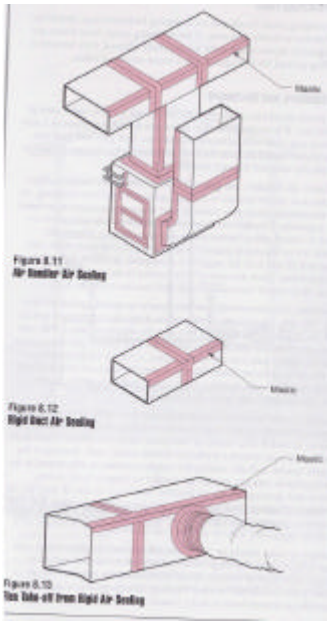
Special attention must also be paid to the mechanical systems of homes with a forced warm air distribution system. The ductwork of many forced warm air systems leak extensively. Leaking ductwork can contribute a significant amount to the cfm 50 leakage identified by the blower door test. In addition, since the ductwork is operating under very high pressure created by the distribution fan, the effects of duct work leakage is exaggerated significantly. Leakage on the supply side of the distribution system, both in the seams of the ductwork, and in any breaks or disconnected ductwork, waste heat in an area that is generally unintended to be heated and may cause areas of the home to be inadequately heated. The return side of the ductwork is usually leakier, since the installing contractor generally paid less attention to the return side connections. The seams of panned floor joists used as a return line may leak extensively. In addition, in most homes there is significantly less return side air than on the supply side, causing the distribution system to get a large portion of its return air through the cracks in the return ductwork. This phenomenon can cause significant negative pressures in the basement, enough to backdraft combustion appliances. Sealing and repairing both the supply and return side of forced warm air distribution systems are a very important component of any air sealing protocol.



Potential Leakage Sites Around Floor Register



Panned Duct



While leaking ductwork can be a significant contributor to the overall infiltration rate, the very presence of the warm air system provides the auditor with two potential air sealing problems. First, the existence of a powerful fan to distribute the heated air throughout the house creates high pressure differences while the fan is operating, exaggerating any existing leakage areas by blowing heated air through the holes. Second, since most distribution systems are poorly balanced and have insufficient returns in many rooms, different parts of the home may be experiencing vastly different levels of exfiltration or infiltration pressures. It is important for the auditor to recognize this phenomenon and pay particular attention to the air sealing of homes with forced warm air systems.

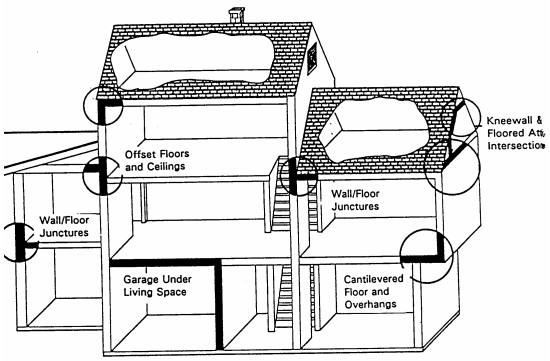
There are also occasions when air sealing work in the basement of the home makes sense. Large plumbing chaseway leaks, especially cutouts under the bathtub, may be part of a series leak that cannot effectively be sealed in the attic. Chimney chases that can be effectively sealed in the attic, need not be sealed in the basement. Large leakage areas in the foundation wall, cellar access doors, and cellar windows may be easy to seal at a low cost. Auditors must use caution when sealing the basement perimeter if those leaks are the primary

source of combustion and ventilation make-up air for combustion appliances located in the basement. It is important to allow for sufficient air for proper ventilation and combustion and to prevent depressurizing the area where combustion appliances are located.

The living spaces of homes are also areas that may need to receive air sealing work. Any obvious leaks directly to the outside, such as missing or broken glass, should be repaired. The fireplace and its damper is a potentially large hole with a built in stack that should be addressed when needed. Occupants tend not to feel leakage around the fireplace since they tend to exfiltrate large volumes of air, creating a draft of makeup air somewhere else in the home. Homeowner's frequently leave the damper open without realizing it. A commercially available "air pillow Draftstopper" or a plywood hatch can be used to stop the leak. Large holes in ceilings and walls should be repaired. Doors between heated and unheated spaces may need to be weatherstripped. Extremely loose windows, particularly those in the spaces frequently used by the occupants, may need to be tightened but should be done so only when absolutely needed. The area above any suspended ceiling should be investigated and repaired as needed.

The auditor and WAP contractor must also consider the impact of wall insulation on the infiltration rate in the home. Dense pack cellulose (installed at >3.5-4 lbs. per sq. ft) is a very effective air sealing measure and may significantly reduce air flow through the wall cavity. If walls are to be completed on a home, particularly one with a balloon frame, the contractor should consider this as a factor in the total air sealing package. In fact dense packing walls with cellulose may be the most cost effective measure that can be completed on many homes, (i.e. those with some existing attic insulation), considering combined infiltration and conductive loss reductions.

Key Junctures in High Density Insulation



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As important as where to complete the air sealing work, is consideration as to how tight a house can be air sealed and still maintain acceptable, safe indoor air quality. Homes must have some ventilation to provide a supply of clean, fresh air to maintain an acceptable level of indoor air quality and to provide adequate air for combustion appliances. While BEP has provided a chart of minimum acceptable Building Tightness Limits (BTL) it is important to recognize that homes with high source strength pollutants that cannot be mitigated should not be tightened and the proper venting of combustion appliances must be established through backdraft testing. Following are the minimum acceptable Building Tightness Limits in the Massachusetts Weatherization Assistance Program with the conditions outlined below:

BUILDING TIGHTNESS LIMITS
(cfm/50 minimum)

Number of Stories	1	1.5	2	3
Well Shielded	1,665	1,500	1,330	1,165
Normal	1,390	1,250	1,110	1,000
Exposed	1,250	1,125	1,000	1,000

Shielding Factors:

Well Shielded	Urban areas surrounded by buildings. Building surrounded by trees, bermed earth, protected by hillside.
Normal	Residential neighborhood with yard space between buildings. 80-90% of houses will fall into this category.
Exposed	Buildings in a very open setting, limited trees, few buildings Buildings on top of a hill or exposed to open ocean or large lakes.

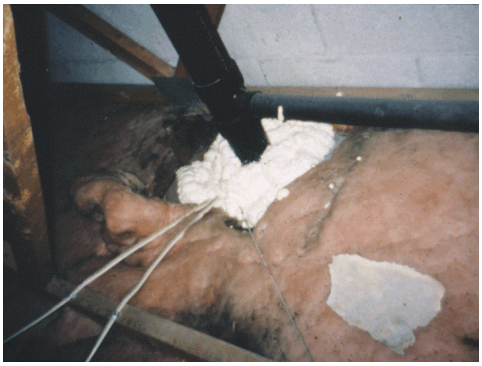
These Building Tightness Limits are based on five (5) occupants in the home. Add approximately 200 cfm/50 per person for larger households. This chart also assumes no high source strength pollutants. The cfm/50 must be raised for smokers, homes with high levels of moisture or any other indoor air quality concerns that cannot be mitigated. Homes with serious indoor air quality problems should receive no air sealing work until the problems can be corrected.

These BTLs do not consider minimum safe depressurization levels to provide for the proper ventilation of combustion appliances. Backdraft testing must be completed to ensure that all vented combustion appliances are safely venting to the outside in the worst case depressurization conditions. Providing combustion air will not necessarily solve a backdraft problem if depressurization levels are high enough.

Auditors must also consider what is a reasonable investment in program resources for air sealing measures. The most effective air sealing techniques are generally not very costly in materials and labor, though some measures may require work in less than desirable locations. The goal in any air sealing strategy is to complete the most effective air sealing for a reasonable cost. The aim is to locate and seal the largest holes in the most important locations and to regularly test the effectiveness of the work using the blower door. The WAP contractor must concentrate their initial air sealing efforts at identifying and sealing the largest holes in the most crucial areas rather than spend a lot of time sealing smaller less significant leaks. The initial efforts must be aimed at identifying major bypasses into the attic, key juncture leakage areas, balloon frame bypasses, bypasses that start in the basement and end in the attic, and any large leakage areas that lead directly into the living spaces from the outside (broken glass, holes in the walls).

Blower door directed air sealing should continue until the contractor reaches the minimum BTL **or the work that is being completed is no longer cost effective**. Contractors should take regular blower door tests during the air sealing work to determine the effectiveness of the work that has been completed. It is generally not cost effective for a contractor to spend a lot of time (and money) attempting to locate and seal small, insignificant leaks. In most homes, the cost of the air sealing work should not exceed $200-300 (exclusive of wall insulation or sealing key junctures that involve the blowing of dense pack cellulose). WAP Auditors must work closely with the contractors to clearly specify the areas to receive air sealing work, and how much work is to be completed. If contractors locate additional areas in need of work, or require additional time to complete their air sealing work, there must be documentation of authorization of the additional work. If contractors are paid by the hour for materials and labor to complete air-sealing work, the contractor's invoice must document the measures completed for the time allocated.

Techniques and materials used to accomplish air sealing measures must be appropriate to the area being sealed. Chimney chases must be sealed with a fire retardant material such as flashing or sheet metal, caulked with an appropriate high temperature sealant such as furnace cement. Large holes should be blocked off with a solid material such as rigid foam board, plywood, or sheetrock. Many times scraps of materials can be used. The solid blocking must be fastened in place and caulked or sealed along the edges as needed. Fiberglass stuffed into a hole is **not** an effective air sealant. One of the more useful materials for air sealing is expanding urethane foam. The urethane foam can fill cracks and holes that are too large for caulking and the expanding nature of the product allows it to effectively fill odd sized or shaped openings. Duct sealing is best accomplished with commercially available latex mastic or butyl backed aluminized tapes.



Dense pack cellulose can be a very effective air sealing measure because its effect is twofold: it both stops air movement and reduces convective losses by increasing the R value. In addition, dense pack cellulose can be installed in areas that may be difficult to access in any other way. Generally, dense pack cellulose can be installed anywhere a contractor can drill a hole, insert a fill tube, and pack a cavity space at a density greater than 3.5-4 lbs. per cubic foot.

Multifamily homes present an air-sealing dilemma. Blower door test readings may be difficult to evaluate. Tests that are conducted on individual units within a multifamily building can be misleading because many leaks can occur between apartments rather than to the outside and it may be difficult to determine which leaks are effective to repair. It also may be impossible to arrange with all the occupants of a multifamily to conduct a blower door test on the entire building. However, multifamily homes generally have significantly larger air sealing needs than smaller single families. Plumbing and chimney chases tend to be larger, many contain large, visible leaks and chaseways in the attic. Most tend to be older, and contain construction details that include leaking key junctures. Some buildings are in very poor repair. Many are balloon framed, both on the outside walls and the central bearing partition. Because of the large leakage potential, it is crucial that the WAP Auditor thoroughly evaluate the air sealing needs and make a complete visual inspection whether a blower door is used or not. Auditors must specify areas to be addressed as part of the work order. BEP strongly recommends the use of the blower door on multifamily homes, primarily as a tool to identify the air sealing needs of the unit.

Air sealing efforts in multifamily homes should be directed at large bypasses that lead to the attic, series leaks, identifying and sealing key junctures, ductwork leakage, and repairing any obvious direct leaks to the outside that are in the living space (i.e. broken or missing glass, holes in the walls, fireplaces with no or ill-fitting dampers).

Blower door directed air sealing should be a systematic approach to reducing the infiltration rate in a building as cost effectively as possible. It is important that contractors not spend a lot of time (and money) looking for and sealing small, inconsequential leaks. WAP Auditors and contractors must understand the concepts of air sealing, and implement an effective protocol on each home weatherized. Close coordination and communication between the auditor and the contractor can ensure implementation of the desired goals. Seal large, cheap to fix leaks in the most important areas first. Test often to check the effectiveness of the work completed. Spend as little money as feasible to **effectively** air seal the home to increase the client comfort, energy savings, and the effectiveness of the insulation installed.

CONDUCTING A ONE POINT BLOWER DOOR TEST

A. Prepare the House

Perform a walk-through inspection of the home. Pick a door to the outside (or a reasonably open unheated porch) that will be free of obstructions within at least a couple feet of the fan outlet. Close all windows (including storm windows) and lock sash locks. All doors to interior rooms should be open. The home should be set up the way the homeowner would typically have it on a winter day. Turn the heating system off. The best way to do this is to turn off the Serviceman, or Customer Emergency Switch. If neither is available turn the thermostat down as low as it will go. If there is a gas-fired domestic hot water heater turn the gas valve to **PILOT POSITION**. Do not turn to OFF. If the home has a fireplace with doors, close the doors tightly. If no doors exist and there are ashes in the firebox, first be certain that they are not hot, then the ashes can be covered with dampened newspaper to be certain that they are not blown into the living space. If the home has a woodstove, be certain that it is not operating, and close the doors as tightly as possible. If the stove is warm you will not be able to take a depressurization test of the home.

B. Set up the Blower Door

Set up the Blower door according to the manufacturer's instructions in the appropriate opening. Keep the fan opening closed by either the fan cap on the older model doors or the low flow plates on the newer model and extend the hose from the top **HOUSE PRESSURE** gauge through the hole in the top panel. If the house pressure gauge fluctuates from the wind, install restrictors in both the house and fan pressure hoses according to manufacturer's recommendations. Adjust the house pressure gauge to 0 with a small screwdriver. Adjust the fan pressure gauges (bottom two gauges) to 0 and connect to the appropriate pressure tap on the fan. The procedure of zeroing the gauges should be done each time the door is set up to ensure accuracy of the readings.

C. Conduct the One Point Blower Door Test

Unless the house is obviously leaky, start the test with the low flow plate installed on the old style door or the outer ring installed on the new style doors. Slowly turn the fan speed up until the house pressure gauge reads 50 Pascal. If the house cannot be pressurized to 50, remove the low flow plate and try again.

When the house pressure stabilizes at 50 Pascal, record the fan pressure and determine the cubic feet per minute of air flow either by the appropriate chart, or read it directly off the gauge on the newer models. Be certain to read the correct line on the chart or the gauge depending on whether or not low flow plates are installed on the fan. This number is the cubic feet of air leakage per minute at 50 Pascal (cfm@50). If the door will not depressurize the home to 50 Pascal even with the open fan, first recheck the house to make certain that all doors, windows and other potential openings are completely closed. If the door still cannot reach fifty, raise the pressure to the highest round number 20, 25, 30, etc. that can be achieved and record both that number and the fan pressure. Determine the cfm reading and multiply that number by the "Can't Reach Fifty" (CRF) factor listed below. For example, if the house pressure with the open fan can only be brought up to 40 Pascal and the fan pressure at that level is 90 Pascal, the actual cfm @ 50 Pascal is 3882 (3235 Pascal read off chart multiplied times "can't reach 50" number for 40 Pascal (1.2).

House Pressure Achieved	CRF Factor
25	1.6
30	1.4
35	1.3
40	1.2
45	1.1

This completes the One Point Test. This number, CFM@50, is the standard used by the air sealing industry to evaluate the tightness of a home.

D. Finishing the Blower Door Test

When all testing is completed, including determining the infiltration rate and locating the major air leaks, be certain to restore the home to its original condition. Replace any furniture that may have been moved. Turn the heating system and water heater back on. Make sure pilot lights are on and heating systems and DHW heaters are operating properly before leaving the home. Restore any woodstove or fireplace to its original condition.

WEATHERSTRIPPING

1. **<u>Requirements</u>**:

Windows: Only extremely loose or drafty movable prime windows which separate conditioned from unconditioned space should be weatherstripped.

Doors: Doors which lead from a conditioned to an unconditioned space, such as basements, attics, or hallways are to be weatherstripped when needed.

2. **<u>Material Standards</u>**:

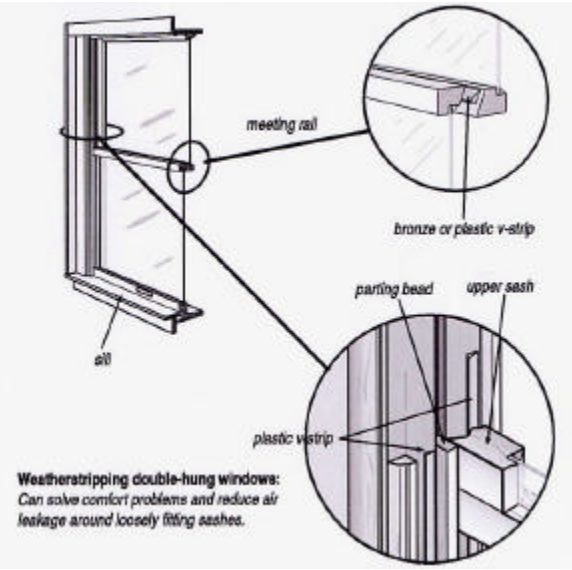
Although the DOE sets the standard for weatherstripping at "commercial availability", the Bureau of Energy Programs requires the installation of a permanent weatherstripping product that has a minimum effective life of ten (10) years.

3. **<u>Recommendations</u>**:

Doors: Rigid metal or wood with a flexible vinyl or silicone weatherstrip.

Windows: Vinyl premolded v-strip or spring metal for double-hung-type windows and gasket-type weatherstrip for metal basement windows. Adhesive backed weatherstripping must be stapled or tacked in place. Stationary or fixed windows must be thoroughly caulked.

<u>NOTE:</u> Windows can often be tightened most efficiently simply by adjusting the stops and installing a good sash lock. Side locks are also an efficient alternative to weatherstripping.



Weatherstripping double-hung windows: *Can solve comfort problems and reduce air leakage around loosely fitting sashes.*

WATER HEATER INSULATION

1. Definition:

A material primarily designed to resist heat flow and suitable for wrapping around the exterior surface of the water heater casing.

2. Requirements and Conditions:

A. Always inspect tank to determine type of fuel (oil, gas, electric) and venting requirements.

1. If an unvented gas unit is found, vent before proceeding with insulation or any other measure and charge the materials to the incidental repairs cost category.

B. Obtain occupant permission for reducing hot water heater temperature setting to 130^{o} F.

C. Insulate hot water heaters (gas, electric, oil) to a minimum R-5.

1. Use either duct wrap or insulation kits specifically designed for hot water heaters.

3. Installation Standards:

A. Apply the insulation to the water heater with the facing to the outside.

B. Secure the sections of insulation by stapling or strapping, in addition to, using high temperature tape.

C. Do not install insulation over the water heater operating instructions and other components identified below.

4. Procedures:

A. Electric Resistance Water Heater

1. Determine the location of pressure relief valve, thermostat control, and high limit switch.

2. Install insulation on the sides and top plate.

3 Cut the insulation to leave holes for the pressure relief valve and plumbing pipes.

4. Cut the jacket for access plates.

B. Gas-Fired Water Heater

1. Determine the location of vent damper. Do not insulate gas-fired water heaters so equipped.

2. Determine the location of the pressure relief valve.

3. Determine the location of the burner air inlet, pilot light access plate, and drain valve.

4. Do not install insulation on the top plate.

5. Cut the insulation to leave holes for the burner air inlet, thermostat control, pilot light access plate, drain valve, plumbing pipes and other necessary plates.

C. Oil-Fired Water Heaters

1. If the vent pipe is top-mounted, do not install insulation on the top plate.

2. If the vent pipe is side-mounted, maintain the minimum vent connector clearances specified in the latest edition of NFPA 211, Standard for Chimneys, Fireplaces, and Vents.

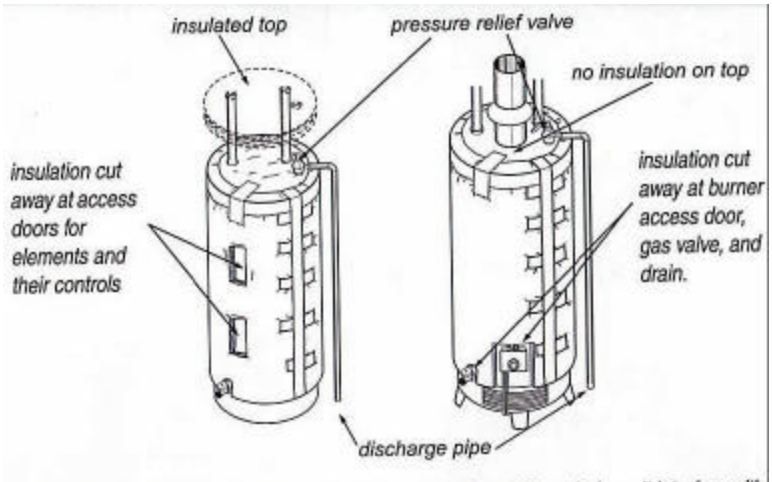
3. Cut the insulation to leave holes for the pressure relief valve, thermostat control, flame peep sight, burner access plate, drain valve, plumbing pipes, and other necessary access plates.

5. Post-Installation Procedures

1. Ensure that the insulation is securely attached with staples and duct tape.

2. Ensure that required clearances are maintained around vent pipes; and insulation has not been installed on the top of oil-fired water heaters, which have a top-mounted vent pipe, or gas-fired water heaters.

3. Ensure that air inlets, access plates, drain valves, temperature controls, and pressure relief valves are not covered by insulation, except where otherwise instructed.



Water heater insulation: *Insulation should be installed carefully so it doesn't interfere with the burner, elements, draft diverter, or pressure relief valve.*

HEATING SYSTEM WORK FOR WAP CLIENTS

Heating system work completed with WAP funds must comply with the following guidance and must be charged to the appropriate categories, properly itemized, and reported on the Building Weatherization Report (BWR). Heating system work, when necessary, is Priority 1a in the WEATHERIZATION MANDATORY PRIORITY MEASURES and must be completed before advancing to subsequent priority measures.

Heating system measures must be included in the Energy Conservation (E.C.) maximum of $4,000. Subgrantees must insure that they do not exceed the HEARTWAP allowable maximum expenditure for any measure on an individual job basis. The maximum for heating system repairs is $600, including any expenditure in the Health and Safety Repair category.

All heating system work must be closely coordinated with the HEARTWAP to insure that clients do not receive duplicative assistance from more than one funding source. In addition, if both WAP and HEARTWAP are involved in a heating system service, the subgrantee must ensure that no contractual maximum expenditure levels are exceeded by the combined resources of the two programs.

Heating System Replacements and Asbestos Abatement should be performed with HEARTWAP funds except in very rare cases. Heating System Replacements, including Space Heaters, and Asbestos Abatement can be completed with WAP funds only with prior BEP approval.

Subgrantees should utilize WAP and HEARTWAP funds in such a manner as to insure that the greatest number of eligible clients will receive heating system assistance. Subgrantees must also insure that they provide a cost effective retrofit package consisting of heating system and building shell measures to all dwelling units which receive assistance. BEP strongly encourages subgrantees to leverage landlord contributions, utility funds, CDBG, and any other supplemental funding to ensure that each building weatherized receives a comprehensive package of energy conservation measures.

Technical, administrative and programmatic standards and requirements regarding heating system measures as mandated in the most current “HEARTWAP Guidance”, are applicable to WAP funded heating system work. Subgrantees which administer both WAP and HEARTWAP may utilize HEARTWAP procured and approved heating contractors. Those WAP Subgrantees that do not administer HEARTWAP must procure heating system contractors consistent with the BEP Procurement requirements.

HEATING SYSTEM MEASURES

Allowable Measures: WAP Priority 1A: Heating System

1. For eligible homeowners or tenants with WAP eligible landlord:

Clean/tune and evaluate (CTE), (max. $70), Report as an Energy Conservation Measure.

Burner replacements due to inefficiency, unsafe or inoperable, (max. $400). Report as an Energy Conservation Measure.

Heating System Repairs (max. $600). Report as Repairs.

Allowable Retrofit Measures, (max $500). Report as an Energy Conservation Measure. Limited to the specific list of retrofit measures in the HEARTWAP Guidance.

Space Heater Service (max. $30). Report as an Energy Conservation Measure.

2. For Tenants with individual heating systems in any size multi-family building:

CTE to improve efficiency (max. $70). Report as an Energy Conservation Measure.

Burner Replacement for reasons of efficiency only (max. $400). Report as an Energy Conservation Measure. If unsafe or inoperable, the landlord must replace or make safe.

Heating System Repairs are the responsibility of the property owner. WAP funds cannot be used to make repairs to the heating system.

Allowable Retrofit Measures, (max. $500) Report as an Energy Conservation Measure. Limited to the specific list of retrofit measures in the HEARTWAP Guidance.

Space Heater Service, (max. $30). Report as an Energy Conservation Measure.

3. For any size multi-family building with a common heating system:

CTE to improve efficiency (max. $70*) Report as an Energy Conservation Measure.

Burner Replacement for reasons of efficiency only (max. $400*) Report as an Energy Conservation Measure.

Heating System Repairs are the responsibility of the property owner.

Retrofit Measures (max. $500). Report as an Energy Conservation Measure. Limited to the specific list of retrofit measures in the HEARTWAP Guidance.

* For commercial sized heating systems in multi-family homes, consult BEP for additional funds, if needed, for the various heating system measures.

OIL-FIRED HEATING SYSTEM MEASURES

The following measures are allowable within the maximum allowable cost per dwelling unit:

1. ***CLEAN/TUNE/EVALUATE (CTE):*** shall include the following measures:

   - Check for oil leaks
   - Check chimney base and flue pipe
   - Check operation of all controls
   - Check pump pressure
   - Check barometric damper operation
   - Check thermostat operation
   - Flush low water cut-off
   - Lubricate all Motors
   - Replace all filters as necessary
   - Clean or change water glass
   - Clean pump strainer and inner housing
   - Replace nozzle
   - Clean electrodes
   - Clean, brush and vacuum boiler and furnace thoroughly
   - Adjust fuel/air for proper combustion
   - Document major code violations

   Every attempt should be made to optimize the firing rate on oil-fired equipment when possible.

   Combustion efficiency test results are required as part of CTEs.

2. ***REPLACEMENT OIL BURNER:*** a flame-retention head device which atomizes the fuel oil, mixes it with air and ignites the fuel-air mixture.

3. ***CLOCK THERMOSTAT:*** a device which is designed to reduce energy consumption by regulating the demand on the heating system in which it is installed and uses:

   A. A temperature control device for interior spaces incorporating more than one temperature control level; and

   B. A clock or other automatic mechanism for switching from one control level to another.

4. ***HYDRONIC BOILER CONTROL:*** A modulating aquastat which closely matches the outside temperature with the BTU requirements of the home and adjusts the circulating boiler water temperature accordingly.

5. ***REPLACEMENT FURNACE OR BOILER:*** The space heating system which provides for the majority of the space heating needs of the residents.

SETTING PRIORITIES ON OIL-FIRED HEATING SYSTEMS

1. **Clean/Tune/Evaluate:**

If a burner has not been serviced within the current heating season, or if any of the combustion efficiency test results are unacceptable, then this option must be considered no less than priority number 1a.

2. **Replacement Oil Burner:**

A burner may not be considered for replacement unless (a) a licensed technician states in writing that the existing burner is unsafe or inoperable, or (b) the combustion efficiency of the burner, after a tune-up evaluation, is 72% or less. Under these circumstances, the priority ranking of this option must be equal to priority number 1a.

3. **Clock Thermostat:**

After all applicable measures have been installed and allowable funds are available, this measure should be considered as an alternative. However, no savings will be realized unless the occupant utilizes the device in accordance with its intended purpose.

4. **Hydonic Boiler Control:**

After all applicable measures have been installed and allowable funds are available, this measure should be considered as an alternative.

5. **Replacement Furnace or Boiler:**

If a furnace or boiler is documented to be unsafe or inoperable or if it is a gravity warm air furnace then it should be placed at the top of the priority list. All heating system replacements should only be performed with HEARTWAP funds, unless BEP prior approval is granted.

6. **Other allowable heating system measures,** which, if applicable, must be performed in conjunction with any other necessary heating system modification:

Line Voltage or Low Voltage Thermostat.

Combustion Chambers: must be rebuilt, relined, replaced or otherwise modified if they are found to be significantly deteriorated or if they are improperly sized. BEP recommends the use of pre-cast mini-combustion chambers and wet chamber lining material (wet pack).

Thermostatic Radiator Valves: provide individual control of radiators, convectors or baseboards in two pipe steam and hot water heating systems. They effectively allow for the balancing of uneven heat distribution systems.

Air Ducts and Connectors: should be properly sized and able to deliver heat to the desired areas. Sufficient cold air return should be present, equal to 100% of the warm air distribution. Seams of the ductwork and connectors must be adequately sealed.

PERFORMANCE STANDARDS

1. Clean/Tune/Evaluate Performance Standards:

The following combustion efficiency test results are considered acceptable for oil-fired heating systems after a clean/tune/evaluate has been performed.

Smoke	0 to Trace
Net Stack Temperature	300 to 600^{o}
Net Stack Temperature with Flame Retention Burner	300 to 400^{o}
CO 2	8 to 12%
O 2	4-8%
Carbon monoxide	less than 100 ppm in flue
Draft at Breach	-.02 to -.04
Draft over Fire	-.01 to -.02

Note: The use of "soot sticks" is not an acceptable alternative to brushing and vacuuming the heat exchanger surface.

If post combustion efficiency test results are found not to be within acceptable parameters, then the attending technician should be required to document the heating system's deficiencies.

2. Burner Replacement Performance Standards:

Oil Burners replaced in coal converted boilers or furnaces must attain a minimum combustion efficiency of 75% with a zero to a trace of smoke.

Oil Burners replaced in design boilers or furnaces must attain a minimum combustion efficiency of 79% with a zero to a trace of smoke.

BEP staff members are the only individuals authorized to grant a waiver of the above standards.

3. Furnace or Boiler Replacement Performance Standard:

Oil-fired furnace or boiler replacements must attain a minimum post-installation combustion efficiency of 80% with a zero to a trace of smoke.

OIL FIRED HEATING SYSTEM QUALITY CONTROL PROCEDURES

1. Take a combustion efficiency and carbon monoxide test.

2. Check for unusual noises and vibrations.

3. Check the flame ignition. Flame ignition should be instantaneous. Delayed ignition is indicative of a combustion problem.

4. Check for flame impingement. Flame should fill the combustion chamber without hitting the sides or back of the chamber.

5. Check the flame cut-off time. The flame should cut off in less than three seconds after the burner shuts off.

6. Check for soot deposits in the flue, combustion chamber, and on the heat exchanger.

7. Check the chimney for problems and the accumulation of soot.

8. Check for oil leaks.

9. Check the draft regulator for any improper adjustments or defects.

10. Check the distribution system.

11. Check for the presence of a Hartford Loop (New Steam Systems only)

The acceptable parameters of a combustion efficiency test on oil fired equipment are as follows:

Net stack	300-500^{o} F
Smoke	0-Trace
CO2	8-12%
O2	4-8%
Draft	.02-.04

The maximum allowable concentration of carbon monoxide (CO) in the flue gas is 100 parts per million. The goal is to have no CO in the flue gas. The ambient air in the area around the appliance shall have no greater than 9 ppm CO.

GAS-FIRED HEATING SYSTEM MEASURES

The following measures are allowable within the maximum allowable cost per dwelling unit:

DEFINITIONS

1. **CLEAN/TUNE/EVALUATE*:*** shall include the following measures:

- Pilot and burner adjustment
- Adjustment of ventilation and combustion
- Check and reset controls
- Replace all filters as necessary
- Lubricate motors
- Flush low water cut-off (steam)
- Check operation of steam and water relief valves
- Check thermostat operation
- Check safety valve
- Check thermocouple - replace if necessary
- Combustion efficiency test
- Document major code violations

2. **CLOCK THERMOSTAT*:*** A device which is designed to reduce energy consumption by regulating the demand on the heating system in which it is installed and uses:

A. A temperature control device for interior spaces incorporated more than one temperature control level; and

B. A clock or other automatic mechanism for switching from one control to another.

3. **HYDRONIC BOILER CONTROL*:*** A modulating aquastat which closely matches the outside temperature with the BTU requirements of the home and adjusts the circulating boiler water temperature accordingly.

4. **POWER BURNER*:*** A burner in which either gas or air or both are supplied at a pressure exceeding, for gas, the line pressure, and for air, atmospheric pressure; this added pressure being applied at the burner.

5. **REPLACEMENT FURNACE OR BOILER*:*** The space heating system which provides the majority of the space heating needs of the residents.

SETTING PRIORITIES ON GAS-FIRED HEATING SYSTEMS

1. Clean/Tune/Evaluate:

If the flame is yellow instead of blue or if after performing a combustion efficiency test the steady-state efficiency is below 75%, then this option must be considered no less than priority number 1a.

2. Clock Thermostat:

After all applicable measures have been installed and allowable funds are available, this measure should be considered as an alternative measure. However, no savings will be realized unless the occupant utilizes the device in accordance with its intended purpose.

3. Hydronic Boiler Control:

After all applicable measures have been installed and allowable funds are available, this measure should be considered as an alternative measure.

4. Power Burner:

This modification should be utilized, when possible and appropriate, to replace inefficient (72% or less efficiency after a tune/clean/evaluate), unsafe, or inoperable atmospheric conversion burners in former oil or coal furnaces or boilers.

5. Replacement Furnace or Boiler:

If a furnace or boiler is documented to be unsafe or inoperable, or if it is a gravity warm air furnace then it should be placed at the top of the priority list. All heating system replacements should only be performed with HEARTWAP funds, unless BEP prior approval is granted.

6. Other allowable heating system measures, which, if applicable, must be performed in conjunction with any other necessary heating system modification:

Line Voltage or Low Voltage Thermostat.

Combustion Chambers: must be rebuilt, relined, replaced or otherwise modified if they are found to be significantly deteriorated or if they are improperly sized. BEP recommends the use of pre-cast mini-combustion chambers and wet chamber lining material (wet pack).

Thermostatic Radiator Valves: provide individual control of radiators, convectors or baseboards in two pipe steam and hot water heating systems. They effectively allow for the balancing of uneven heat distribution systems.

Air Ducts and Connectors: should be properly sized and able to deliver heat to the desired areas. Sufficient cold air return should be present, equal to 100% of the warm air distribution. All duct work seams must be adequately sealed.

GAS FIRED HEATING SYSTEM QUALITY CONTROL PROCEDURES

1. Check the start-up sequence of the appliance.

2. Check the color of the flame. The flame should be blue. A small amount of orange indicates impurities in the gas and is acceptable. A yellow or white flame indicates insufficient combustion air and the likelihood of carbon monoxide production.

3. Check the flame for stability. The flame should be stationary on the burners, not "dancing".

4. Check for unusal noises and vibrations.

5. For gas conversion units, check for a defective or improperly adjusted draft regulator.

6. Take a combustion efficiency, carbon monoxide, and draft test.

7. Check the distribution system.

8. Check for the presence of a Hartford Loop (new Steam Systems only)

The acceptable parameters of a combustion efficiency test on gas-fired equipment are as follows:

Net stack	$300\text{-}500^0$ F
Smoke	0
CO2	7-9%
O2	4-10%
Draft	.02-.04

The maximum allowable concentration of carbon monoxide (CO) in the flue gas is 100 parts per million. The goal is no CO in the flue gas. The ambient air in the area around the appliance shall have no greater than 9 ppm CO.

HEATING SYSTEM EFFICIENCY REPORT

CLIENT NAME: _____ **Job #**

System type: Oil ____ Gas ____ Design ____ Converted ____ Gravity ____ FHW ____ FWA ____ Steam _____

-

Initial Efficiency Test Results

Gross Stack Temp. _____

Net Stack Temp. _____

Smoke _____

CO2/O2 _____

Carbon Monoxide _____

Overfire Draft _____

Breech Draft _____

Efficiency _____ %

Comments:

_____

_____

_____

_____

_____

Signature _____

Date _____

Service Technician's Test Results

Gross Stack Temp. _____

Net Stack Temp. _____

Smoke _____

CO2/O2 _____

Carbon Monoxide _____

Overfire Draft _____

Breech Draft _____

Efficiency _____ %

Nozzle Size _____

Comments:

_____

_____

_____

_____

_____

Signature _____

Date _____

Final Efficiency Test Results

Gross Stack Temp. _____

Net Stack Temp. _____

Smoke _____

CO2/O2 _____

Carbon Monoxide _____

Overfire Draft _____

Breech Draft _____

Efficiency _____ %

Comments:

_____

_____

_____

_____

_____

Signature _____

Date _____

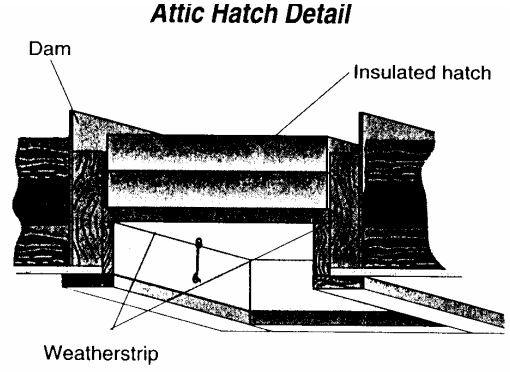
ATTIC INSULATION

1. Definition:

A material or assembly of materials, primarily designed to resist conductive heat loss, which is installed between the conditioned area of a building and an unconditioned attic. Where the conditioned area of a building extends to these roofs, the term attic insulation also applies to material used between the underside of the roof and the ceiling.

2. Requirements:

A. Insulate all finished and unfinished attic areas, where possible, to a settled density (S.D.) of R-38 or R-44 depending on the housing type or fuel source. (See the Weatherization Mandatory Priority Measures chart). To simplify field calculations subgrantees should determine the settled density R-value of loose fill cellulose insulation to be R-3 per inch. Example: R-30 S.D. equals 10" of blown material. Batt type insulation may be used when appropriate. The Weatherization staff should use some discretion as to what level to add attic insulation. Since the greatest conservation impact of added insulation is generally in the first few inches of insulation, in some homes, it would make sense to insulate the attic to R-19 - 22 and use the differential in cost to address uninsulated walls.



B. Properly insulate and weatherstrip all attic entryways, such as: scuttle holes (R-19), walkup stairways (R-5), and pulldown stairways (R-5).

C. Complete and retain on file an Attic Inspection Form for all attic insulation installations.

D. After completing installation of thermal insulation materials, the crew chief or private contractor responsible for the installation must complete and post a "Certification of Insulation" form.

3. Procedures:

Pre-installation procedures (attic preparation)

A. Identify all recessed lighting fixtures, including wiring, compartments, ballasts, vents, chimneys and other heat-producing devices in all areas where insulation is to be installed.

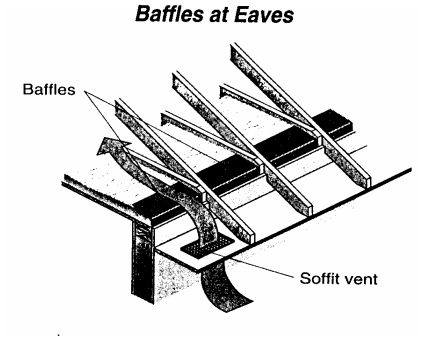
(1) Block off recessed light fixtures with a sheet metal barrier or any number of products commercially available. Install all blocking so that the height of the blocking will be above the level of the finished insulation and in a manner that ensures that all devices that may require maintenance or service remain accessible after the insulation is installed. A three-inch minimum clearance between the fixture and the insulation must be maintained. In addition, do not cover recessed light fixtures. It entraps heat and/or prevents the free circulation of air. ***Massachusetts Energy Conservation Code Section***

2006.4.2. High heat sources: A clearance of three (3) inches from any high heat source, including but not limited to chimneys, flues and vents, shall be maintained for combustible insulating materials.

B. Inspect the room, ceiling, and attic floor to identify areas where a previous moisture problem caused paint peeling, warpage, stain, visible fungus growth, rotting or other structural damage. Do not install insulation in such areas until the resident is informed and these conditions are corrected and their sources eliminated.

C. Inspect the ceilings to insure that they will carry the weight of the insulation. Installing fiberglass batt type insulation may be an acceptable alternative in those areas where the weight of a blown insulation may be a concern.

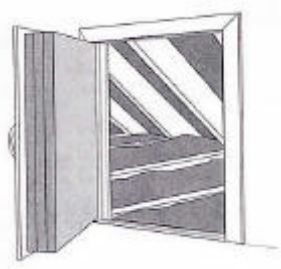
D. Determine if knob and tube wiring is present (see Knob and Tube Wiring guidance).



E. Install permanent blockings to restrain loose-fill insulation from clogging soffit vents at the eaves restricting attic ventilation. Install permanent blocking to ensure free movement of air through soffit vents into the attic, to prevent ventilation air from "air washing" the insulation, and to achieve a uniform R-value and complete coverage over the exterior wall.

F. Air seal any open wall and drop ceiling cavities to prevent filling these areas with cellulose. Attic air sealing consistent with the Blower Door Directed Air Sealing priorities of this manual must be completed to ensure the effectiveness of the insulation. Additionally, the installer must use discretion installing a loose fill insulation in the area of a whole house fan or around duct work that may be present in the attic. Batt type insulation may be recommended in these areas.

G. All attic accessways, either in kneewalls or ceilings, must be installed so that they may be readily removed for post inspection purposes by subgrantee or grantee personnel. In those few cases where this practice would not be practical the subgrantee must ensure that the area insulated is inspected by an appropriate subgrantee representative prior to the permanent sealing of such accessway. This may be the case when a roof or gable end vent opening is utilized as access to an attic or ceiling area. **The subgrantee must fully document, in writing, the results of the in-process inspection.**



VENTILATION REQUIREMENTS

Do not install insulation in an attic space unless adequate and permanent ventilation is installed.

Adequate cross-ventilation shall be maintained above all attic insulation by providing both low and high vents or gable end vents. One square foot of net-free vent area (NFA) shall be provided for every 300 ft^2 of attic area with 50 to 60% of the vent area located near the roof ridge and 40 to 50% located near the eaves. One level of venting may be used provided that adequate cross ventilation can be maintained.

The energy auditor must specify the type number, and location of all vents to the contractor.

NOTE: Although the use of window vents is allowed, the vents must be permanently fixed and must meet the minimum requirements for free vent area as noted above.

VENT PLACEMENT STANDARDS

Vents should be placed so as to eliminate "still" air pockets in the attic. This may be accomplished by distributing the lower vents as widely as possible. Vents should be equally spread to address all attic areas in compliance with the above formulas.

All vents must be screened. Large "can" type roof vents (144 square inches free air) should not be utilized as low-venting where snow may be of concern. The use of active turbine type vents is not recommended in most circumstance as they can create high negative pressures in the attic area causing higher exfiltration from the living space into the attic.

In slate or clay tile roof applications, a combination of gable-end and soffit vents should be used when possible.

All vents shall be installed using manufacturer's recommendations. Holes should be cut to provide a free opening at least equal in size to the opening in the ventilator. There should be no obstructions in the line of the vent opening (be sure to cut and place vents so as to avoid rafters and other structural components). Low vents should be placed a minimum of one foot above the level insulation will be blown. Soffit vents and other low vents, which would cause blowing of loose fill insulation, should be provided with adequate baffling so as to deflect air above the surface of the attic insulation to prevent “air washing” and to prevent blockage of the vents. All necessary precautions should be taken to insure a watertight installation. Roofing should overlap the roof vent flashing at top and sides, when possible.

Attic Inspection Form

Mandatory for all Attic Insulation Jobs

Client Name: _____ **Job #:** _____

Date: _____

Section A: To be filled out by the WAP Auditor during the initial interview with the client.	**Are there any recessed light fixtures in this dwelling?** **Yes** ____ **No** ___ **Don't Know** ____	**Location:** _____ _____
Section B: To be filled out by the auditor upon visual inspection of the ceiling area beneath the attic.	**1. Recessed Lighting Fixtures** _____ _____ _____ _____	**2. Other potential heat producers** _____ _____ _____
Section C: To be completed by the Insulation Contractor at the time of the installation.	**Number of recessed lights:** _____ **Furnace Flues:** _____ **Other Heat Producers:** _____ **Total Guards Needed:** _____	**Should agree with Section B.**
Section D: To be signed by the insulation contractor after completion.	**I have installed** _____ **insulation guards.** **Signed:** _____ **Subgrantee/Company:** _____ **Date:** _____	
Section E: To be signed by the weatherization client.	**I agree that the number of insulation guards indicated have been installed as noted above. I have received the notice to the client that was attached below.** **Signature:** _____ **Date :** _____	

(DETACH HERE AND GIVE TO CLIENT)

Notice to Weatherization Clients: The purpose of insulation guards is to ensure that your dwelling is in compliance with the National Electric Code. The insulation used meets all Federal test specifications. However, since insulation retains heat, it is essential that heat producing sources be protected. For this reason, it is important that insulation guards not be removed, altered or covered. Be sure to use insulation guards if you install new recessed light fixtures or some similar fixture. Also be certain not to obstruct any attic ventilation devices.

CERTIFICATE OF INSULATION

Part 1 - General

Address of Residence:

_____

_____

Date of Installation:

_____

Name and Address of Contractor:

_____

_____

_____

Part 2 - Areas Insulated

WALLS (_____ Sq. Ft.)

Type of Insulation:

_____

Manufacturer:

_____

R-Value Installed **Amount Installed**

_____ _____

CEILINGS (_____ Sq. Ft.)

Type of Insulation:

_____

Manufacturer:

_____

R-Value Installed **Amount Installed**

_____ _____

FLOORS (_____ Sq. Ft.)

Type of Insulation:

_____

Manufacturer:

_____

R-Value Installed **Amount Installed**

_____ _____

Part 3 - Certification

I, _____ , certify that the residence identified in Part 1 was insulated as specified in Part 2 and the installation was conducted in conformance to applicable Codes, Standards, and Regulations.

_____

Signature

This Certificate must be completed and prominently posted adjacent to the electrical panel.

KNOB AND TUBE WIRING

It is mandatory for all WAP Subgrantees to have in its possession a written statement from a licensed electrician or certified electrical inspector, stating that insulation can be safely installed over knob and tube wiring, prior to authorizing the installation of any attic or sidewall insulation in a home where knob and tube wiring is present.

This procedure is the sole responsibility of each WAP Subgrantee and may not be delegated to a private contractor, property owner, tenant or any other party.

In defining the conditions under which insulation can be safely installed over knob and tube wiring in residential attics or sidewalls, the following must be determined:

a. the condition of the wiring;

b. the adequacy of circuit protective devices;

c. the possible need to modify the fuse box to install type "S" fuses; and

d. verification that knob and tube systems are actually in service.

Please ensure that all appropriate Subgrantee personnel and contractors are aware of the importance of this guidance. DHCD/BEP field staff will be monitoring all Subgrantees to ensure compliance with this guidance. All contracts, between DHCD and WAP Subgrantees, allow for the immediate termination of any program found to be in noncompliance with this guidance.

Knob and tube wiring is a potential hazard because it is generally found in older homes (constructed prior to 1920), and these structures were usually wired with a lower electrical service that is inadequate for the requirements of today's households. However, it is now felt that insulation can be safely placed over knob and tube wiring provided that:

- the wiring is in good condition
- the circuits do not carry an amperage greater than the rated current for that size wiring.*

Subgrantees must strictly adhere to the following fuse sizes:

- 15 amp fuses for #14 wire
- 20 amp fuses for #12 wire

The electrician or inspector must check to determine if there is evidence of cracked or frayed electrical insulation or exposed conductors. Installers of the insulation should be cautioned to use care not to damage the old wiring as the insulation is installed.

Installation of type "S" fuses are required in fuse boxes in homes where knob and tube wiring systems are in use. Type "S" fuses insure against overloading by making it impossible to put in a larger rated fuse. Permission must be obtained from the client to modify the fuse box. If the resident does not consent, the insulation cannot be installed.

***** National Electrical Code 19 supports this position.

SIDEWALL INSULATION

1. Definition:

A material designed to resist conductive heat flow, installed within walls between conditioned and unconditioned areas within the structure, or conditioned areas and the outside.

2. Material Standards:

Thermal insulation materials used to insulate sidewall cavities shall conform to those listed in the Appendix A, Standards For Weatherization Materials. **NOTE:** Due to its ability to reduce infiltration in wall cavities, BEP requires the use of cellulose insulation when insulating sidewalls.

3. Inspection and Installation Guidelines:

Determine the amount of existing insulation.

Ask the resident if sidewall insulation has been previously installed into the structure.

Inspect the wall surfaces for evidence of drilling, plugging or removal of the siding materials.

Remove the cover plates for electrical wall outlets/switch plates and examine the cavities for evidence of insulation. Remember to interrupt the electrical current to that area before probing.

If insulation is found in a cavity, determine to what extent the insulation work has been completed throughout the structure.

A. *Inspect the Structure for Evidence of Moisture Damage* (i.e., peeling paint, warpage, visible stains, fungal growth, rot, or other structural damage.) If evidence of moisture damage is determined:

Inspect the gutter/downspout system, siding, and roofing materials, drainage around foundations, and the basement/ crawlspace area for conditions indicating excessive external moisture infiltration.

Determine if occupant behavior, the structure's size or its construction is causing excessive amounts of internally produced moisture.

Conditions that may contribute to excessive internal moisture generation include:

A living area of less than 800 sq. ft.

Less than 250 sq. ft. of living space per occupant.

Tight wall and ceiling construction with thorough leakage sealing completed throughout the structure.

Electrically heated homes or homes with a heating system utilizing outside combustion air.

Homes that are humidified during the winter.

Clothes dryers vented into the living space.

Dirt floored crawlspaces with no vapor barrier.

Locate the source of severe moisture conditions and correct them prior to installing sidewall insulation.

Determine, after exploring all reasonable alternative corrective actions, if the installation of a mechanical ventilation device (fan unit) will adequately control the severe moisture condition(s). Fan units are to be charged to the Health and Safety category.

B. *Inspect the Interior Walls for Structural Integrity*

Examine areas and conditions which might allow insulation to escape into the living space, including pocket doors, balloon construction details (i.e., openings at the top plate, sill plate, and second story ceiling joists), unbacked cabinets and closets, ducts running through exterior walls, as well as interior and exterior wall surface integrity, such as visible cracks, holes, unbacked paneling, etc.

Determine whether those conditions will allow insulation to escape and whether they can be adequately corrected. If the conditions cannot be corrected, determine if the specific area can be left uninsulated without drastically reducing the thermal performance of the entire retrofit.

C. *Inspect the Electrical Service*

Determine whether the wiring runs through the exterior wall cavities and note the conditions of that wiring where is it visible.

Note the wire gauge and ensure that circuit protectors are matched to the appropriate wire size. The following protection is required:

- 15 AMP for #14 Wire
- 20 AMP for #12 Wire

If operable knob and tube wiring is present it is mandatory for all WAP subgrantees to have in its possession a written statement from a licensed electrician or certified electrical inspector, stating that insulation can be safely installed in sidewall cavities which contain knob and tube wiring, prior to authorizing the installation of any sidewall insulation. Consult the Knob and Tube Guidance for further information.

This procedure is the sole responsibility of each WAP subgrantee and may not be delegated to a private contractor, property owner, tenant or any other party.

If the condition of the wiring cannot be corrected and, in the case of knob and tube wiring, the homeowner will not allow the installation of properly sized S-type fuses, determine if

the specific cavities containing wiring can be left uninsulated without drastically reducing the thermal performance of the entire retrofit. Do not complete the retrofit if the conditions cannot be corrected (including owner permission for S-type fuses) or if specific cavities cannot be left uninsulated without drastically reducing cost-effectiveness.

D. *Inspect the Routing of the Mechanical Services*

Locate and note the pathways that plumbing, wiring, heat runs, air return runs and gas lines take through the exterior walls. Take steps to assure that the installation of insulation will not damage or in any way hinder the normal function of those services. In some cases, cavities or groups of cavities may have to be left uninsulated. Determine if the specific area can be left uninsulated without drastically reducing the thermal performance of the entire retrofit.

E. *Inspect the Exterior Siding*

Determine if the siding is of a type that can be loosened or removed in a safe and efficient manner. Sidings must be unlocked/removed unless the homeowner gives the prior written permission to drill and plug them.

Inspect for missing or damaged siding and other conditions which would allow insulation to escape from and/or precipitation to enter into exterior wall cavities.

Document with notations and/or pictures any existing siding problems.

4. Installation Procedures:

A. *Pre-Installation Procedures*

Ensure that the moisture conditions detected in the structure during the course of the initial inspection are corrected prior to insulation of the sidewall cavities. This may be accomplished by one or more of the following techniques:

Provide a vapor barrier on the interior surface of the walls in bathrooms, kitchens, laundry rooms, and any other high moisture areas.

Thoroughly seal all cracks and holes through the interior wall surfaces in high moisture areas.

Install a vapor barrier and ventilation into high moisture crawlspaces.

Correct exterior structural flaws that admit precipitation into the wall cavities, i.e., repair gutter, downspout, drainage system, and seal gaps above door/window casings.

Install an adequate moisture control system in the attic.

Vent clothes dryers to the outside.

Advise the owner/occupants to lower their humidifier and/or to change lifestyle practices which contribute significantly to high humidity.

Install an independently controlled mechanical ventilation device in high moisture living areas.

To the greatest degree possible, moisture problems should be mitigated at the source. Ventilation should be the last resort.

Ensure that all openings in sidewalls through which the insulation can escape are blocked as follows:

Missing interior wall surfaces will be covered with a compatible material (i.e., drywall) and sealed into place.

Missing or damaged exterior siding on homes with incomplete or no subsiding will be replaced/repaired.

Wall cavities with no top plate and/or open at the sill plate will be blocked and sealed with an air impermeable barrier.

Carefully locate and avoid accessing and insulating wall cavities that would either allow insulation to escape or present a hazard to the occupant, installer or the home's structural/mechanical integrity, i.e., heat ducts, recessed lights, vent fans, electrical service entrances, etc.

Lead based paint abatement is not an allowable activity under the Weatherization Assistance Program. See the *Northeast Weatherization Field Guide* for additional information about Lead-Safe Weatherization.

When working on sidewalls that may contain lead based paint, steps should be taken to minimize and contain debris, paint chips, and to avoid the ingestion of lead dust. These steps must include, but are not limited to the following:

Keeping children and pets away from the work area.

Covering the ground beneath the work area with six (6) mil. polyethelene plastic or drop clothes to catch falling debris. Carefully remove the plastic or drop cloth after the work is completed.

Closing all windows and doors to ensure that dust does not blow into the home.

Worker Protection

Detailed specifications regarding the health and safety of workers in the construction industry can be found in Construction Industry OSHA Safety and Health Standards (299CFR 1926/1910).

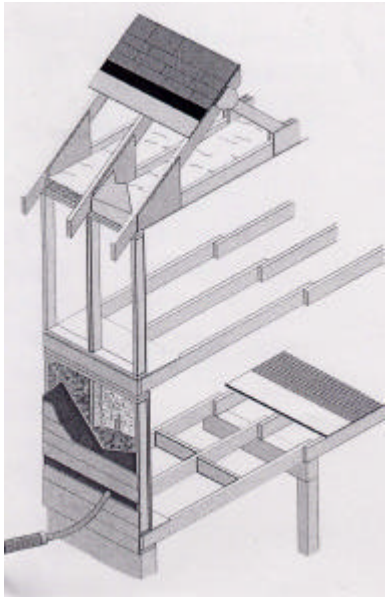
B. *Installation Procedures*

Two (2) basic techniques are acceptable for accessing and insulating sidewall cavities. In any given structure, either or both of the following techniques may be required to assure complete insulation of all wall cavities.

One method involves drilling a minimum of two (2) holes per one story cavity and installing insulation through those holes.

> Access wall cavities with a minimum of two (2) holes per story with no more than 5' distance between those holes. Entry holes will then be probed to locate fire stops or other obstructions which may necessitate additional entry holes to assure the maximum pressurization practical for that cavity. This process applies to exterior siding, subsiding, and interior wall surface applications.

The second method involves drilling one (1) hole in the middle of each one story cavity, inserting a flexible tube through the hole until it reaches the opposite end of that cavity, and installing insulation by withdrawing the tube as the cavity fills.



Access the wall cavities with a single hole drilled in each wall cavity (i.e. through the exterior sheathing after the siding has been removed, top or sole plate, behind the baseboard or crown molding, etc.). **Entry holes must be thoroughly probed to locate fire stops or other obstructions that may necessitate additional access holes**. Additional entry holes must be drilled as needed. A flexible fill tube, long enough to reach to the opposite end of the cavity, must then be inserted into the cavity and withdrawn as the cavity fills and pressurizes.

It is imperative that a fill tube be used with this technique. A single hole technique without a fill tube will not provide adequate density or coverage and is not an acceptable practice in the WAP.

The cellulose insulation should be installed at a density of 3.5-4 lbs. per cubic foot. This density is considered the minimum requirement for “dense pack” and will significantly reduce air infiltration within the wall cavity.

Follow manufacturer recommendations on air pressure settings unless it has been determined by testing that a machine's capability to pressurize a cavity has been altered by mechanical, material, or atmospheric conditions.

Close all entry holes in a professional manner using techniques and materials that ensure a complete, secure seal, with minimum damage to the accessed areas.

Industry standards state that if the exterior siding is removed and replaced, the subsiding need not be plugged prior to the exterior siding replacement.

When limited funds require that a Subgrantee insulate only a portion of all the sidewalls of a building, the auditors decision as to which walls to insulate should be based on the following criteria:

- The level of exposure of the walls to the elements.
- The areas of the home used by the occupants.
- The direction of the prevailing winds.

The auditor should clearly state and diagram which walls are to be insulated and the contractor's invoice must provide the subgrantee with a diagram of the areas that were insulated.

C. *Post-Installation Procedures*

Thoroughly clean the work area and remove any debris or materials left over from the access and installation process.

Prime any wood used in closing the access holes or in other preparatory repairs that is left exposed to the weather.

Assure that the cavity access coverings are securely sealed and fastened into place.

After completing installation of thermal insulation materials, the person responsible for the installation must complete a "Certificate of Insulation" form. The "Certificate of Insulation" must be posted adjacent to the building's electrical service panel.

5. Restrictions:

If a contractor determines that the sidewalls of a building have previously been insulated during any installation, and no further retrofit is possible, then the reimbursement for that measure is limited to $25 for labor expended. The contractor must test drill all the walls.

A contractor always retains the right to perform an inspection of a building's sidewalls prior to accepting a job.

6. Coverage:

Voids of any type or size, other than those previously mentioned are unacceptable when insulating sidewall cavities. BEP requires insulators to return and reinsulate any sidewall areas that lack adequate insulation material.

COMPACT FLUORESCENT LIGHT BULBS

All compact fluorescent light bulbs must be UL approved and must be on a Massachusetts electric utility's list of approved products. All CFLs must be installed by WAP energy auditors and must be billed to the DOE WAP at the subgrantee's purchase price.

A maximum of six (6) bulbs may be installed in each dwelling unit weatherized. CFLs shall be installed only where the fluorescent replaces an incandescent of higher wattage and the fixture is on for three (3) hours or longer on the average day.

Installation Standards

The installation of CFLs must comply with those of the electric utilities' Appliance Management Program.

FLOOR INSULATION

1. **Definition:**

A material primarily designed to resist heat flow and installed between the first level conditioned area of a building and an unconditioned basement or crawl space.

2. **Requirements:**

A. Floor insulation must be a minimum of R-19.

B. The insulation must always be installed with the vapor barrier facing the winter warm side.

C. The insulation must be installed so that there is no space between the floor and the insulation. Do not compress the insulation.

D. The insulation must be mechanically supported with "tiger paws", wiring, twine, staples or strapping.

1. Where insulation is to be installed beneath floors over crawl space:

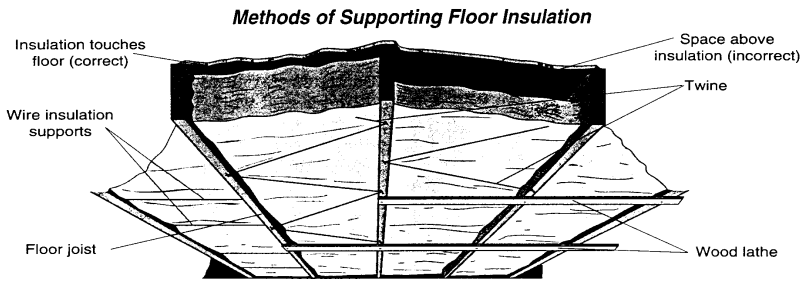
a. Cover all dirt surfaces with a ground cover that acts as a vapor barrier (6 mil. polyethylene sheeting).

b. Provide one square foot of ventilation for every 1,500 square feet of ground area with a vapor barrier, or one square foot of ventilation for every 150 square feet of ground area without a vapor barrier.

3. **Other Considerations:**

A. High levels of floor insulation allow less heat loss from living areas to the basement or crawl space. A cooler crawl space or basement means a greater chance for pipes to freeze. Pipe insulation or other methods of freeze protection must always be a consideration.

B. Floor insulation will prevent any heat that may be present in a conditioned basement from rising and warming the floors. In many such cases, the result may be colder floors in the living space.



Floor insulation is held in place by: 1) wire insulation supports, 2) twine; or 3) wood lathe.

PERIMETER INSULATION

1. Definition:

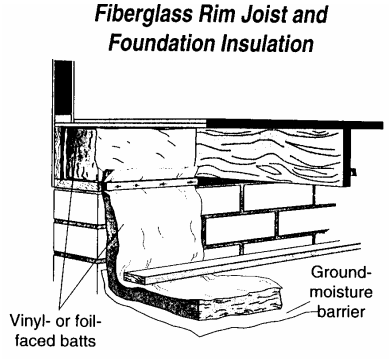
A material or assembly of materials used primarily to provide resistance to heat flow by conduction through the foundation walls.

2. Procedure:

Insulate the interior of basement foundation walls with 1 1/2"- 2" vinyl backed duct wrap or faced R-11 fiberglass batts. The insulation must extend from the top of the sill box to a point at or below the exterior grade. The bottom of the duct wrap must be fastened to the foundation and all seams must be taped.

3. Important Considerations:

The Bureau of Energy Programs does not recommend perimeter insulation in all cases. When the nature of the housing and residents suggest that the insulation will remain in place on a temporary basis at best, this measure should not be attempted. Also, where high levels of moisture is a factor and cannot be effectively controlled, perimeter insulation is not recommended. In addition, since a well installed perimeter wrap may effectively air seal the foundation, consideration must be given to the availability of combustion air for any combustion appliances in the basement area and the potential role of the perimeter insulation in reducing the availability of combustion air. One of the more appropriate applications of perimeter insulation is in conditioned crawlspaces, with no moisture problems, where the entire exposed basement wall can be insulated and the perimeter wrap can be protected from ground borne moisture with a 6 mil. polyethylene ground cover.



DUCT AND PIPE INSULATION

1. Definitions:

Duct Insulation: A material designed to resist heat loss off the ductwork of a forced warm air heating system.

Pipe Insulation: A material primarily designed to reduce heat loss off the surface of exposed water and steam pipes.

2. Procedures:

Duct Insulation:

Seal the seams of all loose fitting joints and any of those that can be shown to leak using a blower door or running the furnace fan, and repair any sections of ductwork that have become disconnected or damaged. Seal and repair both supply and return sides of the ductwork.

Ducts must be sealed with a latex mastic or a butyl backed tape.

Wrap 1 1/2"- 2" vinyl backed duct insulation as completely as possible around the ductwork. Insulate to a minimum of R-5. Insulate only the supply side of the ductwork.

Carefully butt or overlap the ends and seams of the insulation together. All insulation seams must be thoroughly stapled to ensure a permanent seal.

Domestic Hot Water Pipe Insulation:

Be certain that hot water pipes do not leak.

Insulate the first six (6) feet of domestic hot water pipe from the water heater source with a foam type pipe insulation to a minimum of R-3. If the floors above are insulated and there is no heat source in the basement, it may be necessary to insulate all the domestic water pipes.

Hydronic/Steam Space Heating Pipe Insulation:

Be certain that the pipes do not leak.

Insulate the hot water or steam pipes with a pre-formed foam or fiberglass pipe insulation to a minimum of R-5. Tightly butt and seal all joints and miter corners to ensure a tight fit. Insulation must be the correct size for the pipe.

Do not insulate pumps, valves, boiler feed lines, pressure relief devices, or vents.

3. Priorities

Duct Insulation is to be considered a mandatory weatherization priority measure when appropriate. Duct insulation may not always be appropriate. In a conditioned basement that is deliberately warm or heated, duct insulation is not recommended.

Domestic Hot Water Insulation must be installed on the first six (6) feet of hot water pipe as part of the General Heat Waste Priority 1. In some cases, such as unconditioned crawlspaces all pipes may be insulated.

Hydronic/Steam Heating Pipes is to be considered a mandatory weatherization priority measure when appropriate. In a conditioned basement that is deliberately warm or heated, pipe insulation is not recommended.

STORM WINDOWS/REPLACEMENT WINDOWS/ MOVABLE INSULATION SYSTEMS/REPLACEMENT DOORS

DEFINITIONS:

Storm Windows: A unit consisting of glazing material installed in a window opening either outside or inside a prime window, creating an insulating air space to provide greater resistance to heat flow than the prime window alone. The storm window may be removable or permanently attached.

Replacement Windows: A single or double-glazed window unit which would replace the original prime window and would provide for a more airtight construction.

Moveable Insulation Systems:

a. *Window Shutter* - A rigid insulating plate used to cover a window for the purpose of reducing heat loss.

b. *Window Shade* - A device that consists mainly of one or more flexible sheets or quilts and can be unrolled (or vertically raised or lowered) to cover a window and, when not needed, can be moved out of the way.

c. *Window Quilt* - Several flexible sheets of cloth or plastic (or plastic foam) attached to one another in series to form a thick, soft, flexible assembly.

Replacement Doors: A standard or insulated hinged or sliding patio unit which is installed in an exterior door opening and is weatherstripped to provide greater resistance to heat flow.

PROCEDURES:

Interior or Exterior Storm Windows are to be installed on single-glazed window units which separate conditioned and unconditioned spaces. Interior and exterior storm windows must be installed consistent with the recommended priority listing. No reasonably repairable existing storm window may be replaced.

When a dwelling unit consists of double glazed windows, (i.e., exterior storm window and prime window or double glazed primary window) the interior type storm window should be considered as an optional weatherization measure and placed after all other applicable measures listed in the Recommended Weatherization Priority List for the appropriate building type.

Triple glazing of windows must be limited to electrically heated dwelling units or to those situations when the existing primary/storm window assembly or double glazed primary window is in poor condition, and any repair work on the window would either not be cost effective or would disturb lead based paint.

NOTE: *WAP Subgrantees may choose to utilize either exterior or interior storm windows when installing additional glazing. Interior type storms tend to be more cost effective when they are properly utilized because of their lower initial cost and greater effectiveness at reducing infiltration losses.*

Moveable Insulation Systems may be utilized as an insulation material in place of storm windows. Moveable Insulation Systems although effective in selective instances, can be very costly, and must be properly "managed" by the residents to be effective.

Replacement Windows are to be utilized as an allowable weatherization material only after all other reasonable repair options have been considered and rejected.

Replacement Doors, either hinged or sliding patio units, are to be utilized only after all other reasonable repair options have been considered and rejected. Replacement Doors are to be considered as an allowable weatherization material cost. Material costs must be reported as "Other Material" on the BWR.

LIMITATIONS:

Subgrantees are limited to a $500.00 material and labor expenditure on any weatherized unit in the storm window category, inclusive of any associated work, such as the removal of existing storm windows. The maximum expenditure for any "standard" storm window up to 88 united inches is $75.

Window quilts used a fan, air conditioner or pulldown stair covers must be reported on the Building Weather Report (BWR) as "Other Material", not "Storm Windows

Subgrantees are encouraged to use extreme caution in the use of replacement windows or sashes as a conservation measure. First, due to their high cost and low potential for savings, they are generally not cost effective as an energy conservation measure. Second, in many instances the installation of replacement windows or sashes results in disturbing lead paint, in violation of the BEP Health and Safety Guidance.

INCIDENTAL REPAIRS

Incidental Repairs are those "repairs to the dwelling unit which are necessary for the effective performance or preservation of an allowable energy conservation measure". An incidental repair may only be performed in conjunction with an allowable energy conservation measure. Thus, reshingling a leaking roof or upgrading the electrical wiring in an attic may be performed when a subgrantee is going to insulate the attic.

Following is a list of some of the most common repair materials utilized by WAP subgrantees:

Lumber
Roof and sidewall shingles
Flashing
Vinyl, aluminum, and clapboard siding
Masonry supplies
Window repair items (glass, locks, parting beads, ropes, sidestops, channels)
Gutters and downspouts
Paint, stain, sealers

Incidental repairs are limited to a maximum of $600 per eligible dwelling unit, inclusive of labor and materials. The cost of "incidental repairs" is in addition to the maximum cost of allowable energy conservation measures.

The cost of "incidental repair" must be reported on the Building Weatherization Report (BWR) in the appropriate category.

QUALITY CONTROL PROCEDURES

A comprehensive, detailed, and fully documented Quality Control procedure is a required component of the Weatherization Assistance Program. Each Subgrantee must have a Quality Control procedure that is routinely used to assess the quality and completeness of the weatherization work completed by contractors and crews. This procedure must be fully documented.

Whenever a Subgrantee weatherizes a dwelling unit, a Massachusetts WAP Certified Energy Auditor who is an employee of that agency must inspect and approve as complete, all work invoiced by a contractor, prior to issuing payment to that contractor and submitting the job to DHCD/BEP. If there are any problems or discrepancies with the work, the Subgrantee must document the resolution of the problem, including any required follow-up inspections, prior to payment. If agency crews are used on a weatherization job, an agency staff member not associated with that crew must inspect the work and certify that the work was acceptable and all materials listed were installed as specified prior to submitting that job to DHCD/BEP as a completion.

Each Subgrantee must develop clear documentation of proper Quality Control procedures. When using contractors, the Subgrantee must develop a procedure that includes a standardized Quality Control form used in conjunction with the contractor's itemized invoice. The Quality Control inspector must check off each item as complete and acceptable prior to contractor payment. All insulation jobs must be remeasured to ensure the accuracy of the square footage. **All Quality Control forms must be signed and dated by the inspector.**

If a contractor must seal off an insulation accessway or uses roof or gable end vents as access to an attic area, no matter how small, the Subgrantee must perform a visual inspection of the work prior to that area being sealed off. If the area does not receive a visual inspection prior to being closed off, the Subgrantee must return with the contractor, reopen the area, and inspect the work. The inspector must certify that the work (insulation, air sealing) is complete and installed according to specifications. This inspection must be completely documented and included in the client file.

DHCD/BEP strongly recommends that Subgrantees require contractors to notify the WAP office prior to the day that they are beginning weatherization jobs for the agency. The Subgrantee should then plan to make regular, unannounced in-process inspections to determine that the WAP contractor is completing the work in an acceptable manner. These in-process inspections also offer the opportunity for the Subgrantee auditor and the contractor to discuss any problems or concerns about the job. The in-process inspection must be documented and does not preclude the need for a final inspection of the job after all work is completed.

The final Quality Control inspection must also include Health and Safety testing consistent with the requirements outlined in the **BEP HEALTH AND SAFETY GUIDANCE.**

POST INSTALLATION QUALITY CONTROL REPORT

Client Name: _____ **Job #:** _____

Address: _____ **Date:** _____

Contractor: GHW/Air Sealing: _____ **Insulation:** _____

Storm Window: _____ **Heating System:** _____

			Quality of Work				
Weatherization Measure	**Work Required**	**Work Invoiced**	**Good**	**Fair**	**Poor**	**None**	**Comments**
Window Work							
Weatherstripping							
Sash Locks							
Glass Replacement							
Window Locks							
Sash Replacement							
Other							
Doors							
Weatherstripping							
Repairs							
Replacement							
Living Area							
Electric Gaskets							
Interior Caulking							
Other Interior Air Sealing							
Attic Air Sealing							
Chimney Chase							
Top plates							
Plumbing Bypasses							
Other Major Bypasses							
Key Junctures							
Kneewall Trans. Area							
Cantilevered Areas							
Porch Roofs							
Other Areas (List)							
Attic Insulation							
Flat Area	sq.ft.	sq.ft.					
Attic Area 2	sq.ft.	sq.ft.					
Slopes	sq.ft.	sq.ft.					
Kneewall Area	sq.ft.	sq.ft.					
Kneewall Floor	sq.ft.	sq.ft.					
Attic Accessway							
Blocking and Damming							
Other							
Ventilation							
Gable Vents							
Roof Vents							

Weatherization Measure	Work Required	Work Invoiced	Good	Fair	Poor	None	Comments
Ridge Vent							
Soffit Vents							
Basement Area							
Duct Sealing							
Chimney Chase							
Major Plumbing Chases							
Perimeter Sealing							
Other							
Floor Insulation	sq.ft.	sq.ft.					
Perimeter Insulation							
Duct Insulation							
DHW Tank Insulation							
Pipe Insulation	lin.ft.	lin.ft.					
Other Repairs (List)							
Sidewall Insulation							
Square Footage Insulated	sq.ft.	sq.ft					
Proper Accessing							
Condition of Siding							
Storm Windows							
Exterior							
Interior							
Repairs							
Certificate of Insulation							
Heating System Work							

The work invoiced is certified complete and ready for payment.

Signature of Inspector:_____ **Date:** _____

Follow up Required: _____ **Date:** _____

Call back completed: _____ **Date:** _____

Final Carbon Monoxide test results

Heating System _____ **ppm**
Domestic Hot Water _____ **ppm**
Kitchen Range _____ **ppm**
Dryer _____ **ppm**
Other Combustion Appl. _____ **ppm**

Backdraft Test

Acceptable _____ Not Acceptable _____

Additional Comments:

GUIDELINES FOR THE WEATHERIZATION OF MULTIFAMILY RENTAL BUILDINGS

Following is the procedure for weatherizing buildings with two or more units.

Buildings with less than 50% of the dwelling units eligible

When less than 50% of the dwelling units in a building are eligible for weatherization, the following procedure is mandatory:

All applicable Major Air Sealing/General Heat Waste, Heating System, and Wall Insulation must be completed to the eligible unit.

All common areas (hallways, attics, basements) that are immediately adjacent to the eligible unit must be weatherized.

The building's ineligible units cannot be weatherized.

Allowable expenditures are limited to those of the eligible unit or units and production credit will be granted for the eligible unit(s) only.

Building with five (5) or more units and 50-65% of the units are eligible

When buildings with five (5) or more units and 50-65% of the units are eligible for weatherization, the following procedure is mandatory:

All applicable Major Air Sealing/General Heat Waste, Heating System and Wall Insulation measures must be performed to the eligible units.

All common areas (hallways, attics, basements) regardless of their location in relation to the eligible unit, must be weatherized.

The building's ineligible units cannot be weatherized.

Allowable expenditures are limited to those of the eligible units and production credit will be granted to the eligible units only.

50% of the units in a two (2) or four (4) unit building or at least 66% of the units in any building are eligible

When 50% of the units in a two (2) or four (4) unit building or at least 66% of the units in any building are eligible for weatherization the subgrantee may elect either of the following procedures:

1. The Subgrantee may elect to weatherize the entire building including all eligible, and ineligible units and all common areas. If the subgrantee elects this option, the following procedure is mandatory:

   The entire building must be weatherized consistent with the applicable Massachusetts Weatherization Priority Measures regardless of the location of the eligible units.

Allowable Energy Conservation expenditures are limited to a total of $4,000 x the number of income eligible units in the building.

Health and Safety/Repair expenditures are limited to $600 x the number of income eligible dwelling units in the building.

Total Program Operations (Energy Conservation, Repair/Health and Safety) expenditures are limited to a total of $4,600 x the number of eligible units in the building.

A Building Weatherization Report (BWR) must be submitted for each unit completed. Costs that can be directly attributed to that unit must be reported on that unit's BWR (i.e. costs associated with Air Sealing/General Heat Waste or wall insulation for that unit). Costs associated with common areas in the building can be charged off to the adjacent unit or divided among the units in such a manner that that will ensure that the building receives maximum weatherization services. **Ineligible units must be clearly labeled as such in the Client Demographic Section of the BWR**.

Subgrantees must ensure that the regulatory maximums for Energy Conservation and Repair/Health and Safety are not exceeded on any individual BWR.

Production credit will be granted for each ineligible unit weatherized with a minimum $200 expenditure.

2. The Subgrantee may elect to weatherize only the eligible unit or units and common areas in the building. If the Subgrantee elects this option, the following procedure is mandatory:

   All applicable Major Air Sealing/General Heat Waste, Heating System, and Wall Insulation must be completed to the eligible unit(s).

   All common areas (hallways, attics, basements) regardless of their location, must be weatherized.

   The building's ineligible units cannot be weatherized.

   Allowable expenditures are limited to those of the eligible unit or units and production credit will be granted for the eligible unit(s) only.

The Guidelines for the Weatherization of Multifamily Rental Buildings apply only to buildings where a minimum of one dwelling unit is occupied by a tenant. Privately owned condominiums and cooperatively owned buildings may not receive assistance under these Guidelines (including provisions for weatherizing income ineligible units) unless one or more units is occupied by a tenant. These privately owned units may receive assistance on an individual basis, based on the eligibility status of the owner.

Weatherization of Vacant Units

A vacant unit must always be weatherized as an ineligible unit. Vacant units **cannot** be weatherized using LIHEAP Funds. The only case in which a vacant unit may be weatherized as an eligible unit is when the building is being rehabilitated under a local, state, or federally funded rehabilitation program in conjunction with CDWAP. Weatherizing these units requires BEP prior approval under the Special Projects Guidance in all instances.

Subgrantees may not sign "Vacant Unit" agreements with building owners on the promise that the units will be occupied by eligible tenants outside of the CDWAP process.

Multifamily Dwelling Client Prioritization Policy

BEP will waive the mandatory client priority requirements in those cases in which the weatherization of an entire building is possible, and at least one dwelling unit in that building is classified as a priority client. In these cases, the cost effectiveness of the whole house approach will take precedence over the priority status of the remaining units in the building. This waiver does not apply to any income ineligible units in the building.

BWR COST SECTION MATERIAL BREAKDOWN

Weatherization measures completed must be itemized and reported in appropriate costs section on the BWR as itemized below:

1. Weatherstripping and Sealants

Door and Window Weatherstripping
Electrical Outlet Gaskets
Caulking and Sealing Material
Glazing Compound
Duct Sealing Materials
Putty
Spray-type Foams
Materials that have a Primary Function of Air Sealing, (i.e. Pieces of Foam Board, Metal Flashing used to seal a chimney chase)

2. Insulation

Fiberglass; Batt, Blanket, and Blown
Cellulose, Vermiculite, Perlite
Rigid Foam Board
Hot Water Heater Insulation
Pipe and Duct Wrap
Attic Hatch and Pulldown Stairway Insulation

3. Storm Windows

Exterior Storm Windows
Interior Storm Windows
Moveable Insulation Systems for Windows

4. Heating System

Combustion Chambers
Replacement Oil and Gas Power Burners
Clean Tune and Evaluate Materials
Thermostats, Standard and Clock
Hydronic Boiler Controls
Thermostatic Radiator Valves
Air Ducts and Connectors

5. Other Materials

Window Sash
Primary Window Units
Insulation Guards
Vapor Barriers
Replacement Windows
Ventilation Devices
Replacement Doors
Low Flow Showerheads/Flow Restrictors
Faucet Aerators
Water Pipe Heater Strips
Compact Fluorescent Lighting
Window Quilts used to cover fans, air conditioners and pulldown attic stairways.

6. Repair Material

Glass/Parting Beads/Side Stops
Window Locks, Ropes, and Channels
Glazing Points
Window and Door Trim
Nails/Screws/Brads/Other Fasteners
Glue/Adhesives
Flashing (except to air seal chimney chase)
Lumber/Shingles/Siding
Masonry Supplies, Bricks, Blocks, Mortar
Paint/Stain/Sealers
Sheetrock/Plaster
Gutters/Downspouts
Mobile Home Roof Sealants
Skirting
Repairs to the Primary Heating System

7. Health and Safety

Gas Leak Repairs
Carbon Monoxide Mitigation
Bathroom/Kitchen Exhaust Fans and Vents
Dryer Vents
Electrical Wiring, Fuses, Boxes, and Inspections